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User's Manual for Chemical Mass Balance Model

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16. ABSTRACT

In recent years there has been increasing interest in source apportionment of ambient aerosol concentrations through chemical mass balance (CMB) analysis. This report discusses CMB analysis through weighted least squares with options to include effective variance and ridge regression features. Effective variances are refined estimates of the weights employed in weighted least squares.

This report documents an interactive FORTRAN computer program which performs aerosol source apportionment through the analysis methods discussed above. The original version of the program, which performed weighted least squares with the effective variance option, was developed at the Oregon Graduate Center based on the Doctoral Dissertation of Dr. John Watson. In the current version, a ridge regression feature was added, along with various modifications intended to enhance the ease of use of the program.

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VOLUME III

User's Manual For Chemical Mass Balance Model

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RECEPTOR MODEL TECHNICAL SERIES

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User's Manual For Chemical Mass Balance Model

By

Hugh J. Williamson
Dennis A. DuBose

Contract No. 68-02-3513

EPA Project Officer: Warren P. Freas

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Office of Air, Noise and Radiation
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PREFACE

Receptor Model Technical Series
Volume III
User's Manual for Chemical Mass Balance Model

Recent improvements in air sampling and analytical techniques have stimulated rapid growth in new techniques of source impact analysis using receptor models. These models "decode" the chemical fingerprints and variability of the ambient aerosol to back-calculate source impacts. Unlike source (dispersion) models that estimate source impacts from emission rate, meteorology and stack parameters, receptor techniques estimate source contributions to the total, fine, coarse, or inhalable particulate mass using data from ambient aerosol measurements.

This document is the third of a series describing how receptor models can be used by State and local regulatory agencies to identify particulate source impacts. Volume I (EPA-450/4-81-016a) provides an overview of Receptor Model Applications, while Volume II (EPA-450/81-016b) focuses on the Chemical Mass Balance (CMB) technique, model theory and input requirements.

This report documents an interactive FORTRAN computer program which performs aerosol source apportionment through weighted least squares with options to include effective variance and ridge regression features. The original version of the program, which performed weighted least squares with the effective variance option, was developed at the Oregon Graduate Center based on the Doctoral Dissertation of Dr. John Watson. The program was later modified at Oregon by Dave Torkelson. The current version has been developed under contract to EPA by Drs. Hugh Williamson and Dennis DuBose of Radian Corporation. In the latest version, the ridge regression feature was added, along with various modifications intended to enhance the ease of use of the program.

The computer program described in this manual is available on magnetic tape as EPA-450/4-83-014b and can be acquired in either of two ways:

1. Government and nonprofit agencies may obtain a copy of the program by sending a blank magnetic tape and written request to:

Chief, Technology Development Section
Air Management Technology Branch/MDAD (MD-14)
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina 27711
Attention: Receptor Model Request

2. Others wishing a copy of the program may purchase it from the National Technical Information Service, Springfield, Virginia 22161, telephone (703) 557-4650.

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This report has been reviewed by the Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, and approved for publication as received from Radian Corporation. Approval does not signify that the contents necessarily reflect the views and policies of the U.S. Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

ABSTRACT

This report presents a discussion of aerosol source apportionment. Chemical mass balance (CMB) equations are used to estimate the contributions of the important source types to an ambient particulate concentration. Separate analyses are ordinarily performed for the fine and coarse size fractions. The basic solution technique discussed is weighted regression analysis. In this method, the more accurate ambient concentration data are weighted more heavily to produce a better solution. The analysis technique can be modified to include the effective variance feature, the ridge regression feature, or both. In the effective variance feature, the uncertainties of all input data (ambient and source) are employed in the analysis. Effective variance calculations produce a weighted least squares solution with refined estimates of the weights. The ridge feature is especially designed to handle cases in which the particulate emissions from different sources are chemically similar. Ridge regression potentially allows more resolution in the source apportionment, in that a more complex set of sources can often be handled. The report also documents an interactive computer program which performs source apportionment using the techniques discussed above. A set of examples of CMB applications is presented to illustrate the various options of the program.

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SECTION 1
MODEL OVERVIEW

1.1 Background and Purpose

This report documents an interactive computer program which can be used to perform an analysis of the sources of ambient aerosol concentrations. Figure 1-1 summarizes the objectives to be achieved by source apportionment. The problem to be addressed consists of the presence of objectionable or hazardous atmospheric particulate matter. Source apportionment provides an approach for addressing the problem.

"Source apportionment," "source receptor modeling," and "chemical mass balance (CMB) analysis" are terms which refer to a statistical analysis through which the major contributors to ambient aerosol pollution are identified. Specifically, an ambient particulate concentration is apportioned among its sources. For example, if the concentration was 110 μg/m^3, the analysis might indicate that 40 μg/m^3 came from source A, 35 μg/m^3 from source B, etc. The "sources" are source categories such as windblown dust, automobiles, petroleum refineries, etc. The exact set of sources which should be included varies geographically. Separate source apportionments are usually performed for the fine and coarse size fractions. Apportionment can be made based on the concentrations determined from a single aerosol sample or based on the average concentrations from a set of samples.

The required chemical inputs consist of (1) the chemical characteristics of the aerosols from each source type to be considered, and (2) the chemical characteristics of the ambient aerosols. It is also possible to use the uncertainties of the input data in the analysis. This allows the more accurate data to be weighted more heavily to produce a better solution.

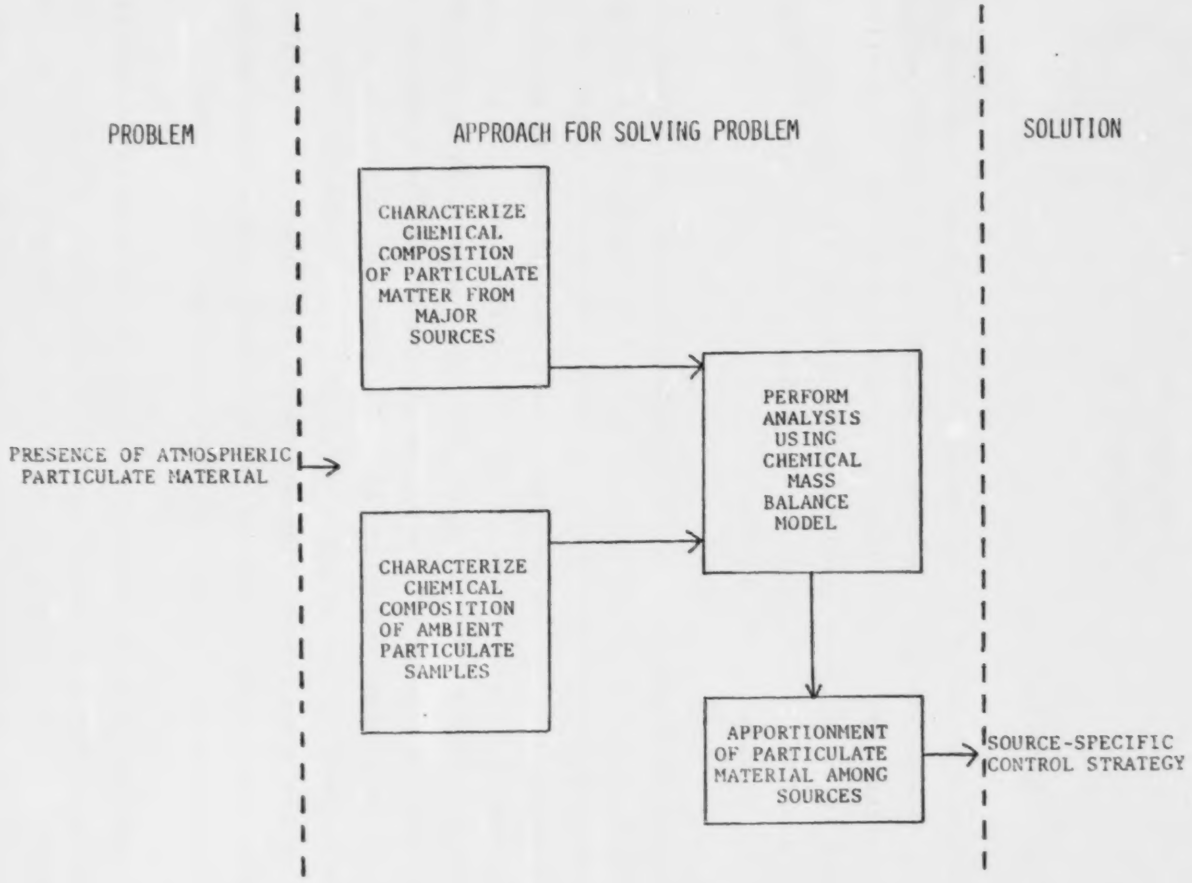
PROBLEM
APPROACH FOR SOLVING PROBLEM
SOLUTION
PRESENCE OF ATMOSPHERIC PARTICULATE MATERIAL
CHARACTERIZE CHEMICAL COMPOSITION OF PARTICULATE MATTER FROM MAJOR SOURCES
CHARACTERIZE CHEMICAL COMPOSITION OF AMBIENT PARTICULATE SAMPLES
PERFORM ANALYSIS USING CHEMICAL MASS BALANCE MODEL
APPORTIONMENT OF PARTICULATE MATERIAL AMONG SOURCES
SOURCE-SPECIFIC CONTROL STRATEGY

Figure 1-1. Source Apportionment of Ambient Particulate Material

A statistical model which employs a set of mass balance equations is used to apportion the particulate matter among its sources. A separate mass balance equation is employed for each of a set of chemical species. An additional mass balance equation employs the aerosol concentration for the size fraction being considered. The inputs (1) and (2), above, contain information regarding the set of species selected for inclusion in the analysis and for the aerosol concentration.

The knowledge of which sources are the largest contributors to the ambient aerosols plays an important role in the formulation of a source-specific control strategy. Additionally, source apportionment is a valuable research tool.

The basic solution technique discussed herein is weighted least squares. In this technique, the more accurate input ambient concentrations are weighted more heavily to produce a better solution. The following major options regarding the solution technique are also available:

(1) Effective variance calculations--a procedure through which the errors in the complete set of chemical input data are taken into account in weighting the more accurate data more heavily to produce a better solution. If effective variances are not used, the uncertainties in only the ambient concentration data are used.

(2) Ridge regression--a feature designed specifically to handle cases in which the aerosols of two or more sources are chemically similar. Soil, road dust, and asphalt production is ordinarily such a set. If conventional statistical techniques are used rather than ridge regression, it is usually necessary to combine sources with similar aerosols into groups and apportion the ambient aerosols among the groups. The separate contributions of the different sources within a group, however, are not quantified. Ridge regression provides an opportunity to achieve greater resolution through analysis of a larger set of separate source categories.

Even with ridge regression, however, it is not possible to separate the influences of sources whose aerosols are chemically indistinguishable. A discussion of the pros and cons of ridge regression is presented in Section 2.2.

1.2 Definitions of Terms

This subsection presents a set of definitions of technical terms used in this report. The reader may wish to scan the definitions for an introduction to the terms and to refer to them while reading the report. Expanded discussions of many of the terms as they apply to source apportionment are presented in the following sections.

Source receptor analysis--a type of statistical analysis through which an ambient aerosol concentration is apportioned among its sources. The terms "source apportionment analysis" and "chemical mass balance (CMB) analysis" are used in the same sense in this report.

Chemical mass balance equation--an equation in which a mass or concentration is equated to the sum of its parts. In this context, the ambient aerosol concentration is equated to the aerosol concentration due to source one plus the concentration due to source two, etc. Similar mass balance equations are used for individual chemical species which make up the ambient aerosol.

Vector--a one-dimensional array of numbers, e.g., X_1, X_2, ... X_i ... X_n.

Matrix--a two-dimensional array of numbers, e.g., X_{ij}, i=1 to n, j=1 to m. Notice that a given row or column of a matrix can be thought of as a vector.

Source signature--a quantification of the chemical characteristics of the aerosols from a particular source. A source signature is a vector whose i^{th} value is the fraction of the aerosol from a specific source which is composed of chemical species i. Suppose, for example, that the soil in an area consisted of 20% silicon. Then the entry in the source signature for soil corresponding to silicon would be 0.20.

Source signature matrix--a matrix whose columns are the signatures for a set of sources.

Standard error--the standard deviation of the error in a quantity. For example, the standard errors of the ambient concentrations and of the source signatures are required inputs if a CMB analysis is performed using weighted least squares with effective variances.

Error variance--the square of a standard error.

Regression analysis--a statistical method by which a mathematical model is developed to predict a dependent variable in terms of one or more other variables. The coefficients in the model are selected so as to minimize the sum of squares of the differences between the observed and predicted values in the data set being used. Regression is also referred to as ordinary least squares.

Regression coefficient--a parameter in a regression model whose value is estimated from the data.

Weighted least squares--the same as regression analysis, except that the values of the dependent variable are weighted according to their uncertainties in order to produce a more accurate solution.

Effective variance--the error variance in an equation, taking into account the uncertainties in both the dependent variable and the predictor variables. In a refinement of weighted least squares, effective variances are used in place of the error variances of the dependent variable alone.

The objective is to weight the data according to all input uncertainties in performing the model development.

Observation--the vector of values of all variables being considered in an analysis for one case. In regression analysis, for example, an observation consists of a value of the dependent variable and the corresponding values of the independent, or predictor, variables.

Sample size--the number of observations used in a statistical analysis.

Iterative solution--an approximate answer to a particular problem accomplished by computing a succession of estimates of the true answer. If the procedure is successful, the estimates approach the true answer as the number of approximations generated increases. Thus, beyond some point, consecutive estimates differ very little from each other. As is discussed in Section 2, an iterative solution is required if effective variances are used.

Iteration--the set of calculations required to produce one of the estimates in an iterative procedure.

Correlation coefficient (R)--a measure of the strength of the linear relationship between two variables. If the correlation is one, a perfect linear relationship exists, and one variable increases as the other increases. If the correlation is minus one, a perfect linear relationship exists, and one variable increases as the other decreases. If the correlation is zero, no linear relationship exists between the two variables at all. The square of the correlation coefficient, R^2, can be interpreted as the fraction of the original scatter in one variable that can be explained or predicted in terms of the other.

Multiple correlation coefficient (R)--a measure of the strength of the linear relationship between a dependent variable and two or more other variables. If the dependent variable can be predicted perfectly from the other variables, then R is one. If the dependent variable has no linear relationship at all with the other variables, then R is zero. The quantity R^2 is the fraction of the scatter in the dependent variable that can be explained or predicted in terms of the other variables.

Linear combination--a variable X_0 is a linear combination of another set of variables $X_1, X_2, \ldots X_n$ if a set of coefficients $A_0, A_1, A_2, \ldots A_n$ exist such that $X_0 = A_0 + \sum_{i=1}^{n} A_i X_i$.

Multicollinearity--a certain condition which affects the accuracy of the results of a regression analysis. In the simplest case, multicollinearity exists if two predictor variables are highly correlated. In source receptor modeling, this occurs if two sources have very similar signatures. In a more general sense, multicollinearity exists if any predictor is nearly a linear combination of any subset of the other predictors. When strong multicollinearities are present, conventional regression techniques typically produce results with large uncertainties.

Variance inflation factor--a measure of the effect of multicollinearity on a regression coefficient. A variance inflation factor is the increase in the error variance of a specific regression coefficient due to the effect of multicollinearity alone. If the variance inflation factor for a particular coefficient was one, this would indicate that that coefficient was not affected by multicollinearity at all.

Ridge regression--a type of regression analysis which is specifically designed to handle cases affected by multicollinearity. In CMB analyses, ridge regression has enhanced ability to perform apportionments among sources whose aerosols are chemically similar. However, apportionment among sources whose aerosols are chemically indistinguishable is not feasible even with ridge regression. See the discussion in Section 2.2.

Bias--a systematic as opposed to a random error.

1.3 Overview of Use of Interactive Source Apportionment Software

This report documents an interactive computer program which can be used to perform source apportionment analyses. In each interactive session, one or more separate source apportionments can be performed at the option of the user. A brief overview of the procedures for using the program is presented here. The overview is summarized in Figure 1-2. The procedures are discussed in detail in Section 3.

Before an interactive session, the required input data must be prepared. The following five data files are required:

List of Source Codes
List of Species Codes
Source Signature Matrix (Fine Particulate Fraction)
Source Signature Matrix (Coarse Particulate Fraction)
Ambient Particulate Concentration Data

The source code file consists of a numeric code and an alphanumeric code for each source. The species code file requires similar information for each chemical species included in the analysis. These files are used only for labeling and indexing purposes. The source signature and ambient concentration data are used directly in the calculations.

An interactive session has two phases. The first is the initialization phase, which consists of a series of queries and prompts from the program that require responses from the user. In this phase, the user selects the initial set of sources and chemical species to be considered.

In the second phase, the program prompts the user to enter commands. In response to some commands, the program queries the user for additional

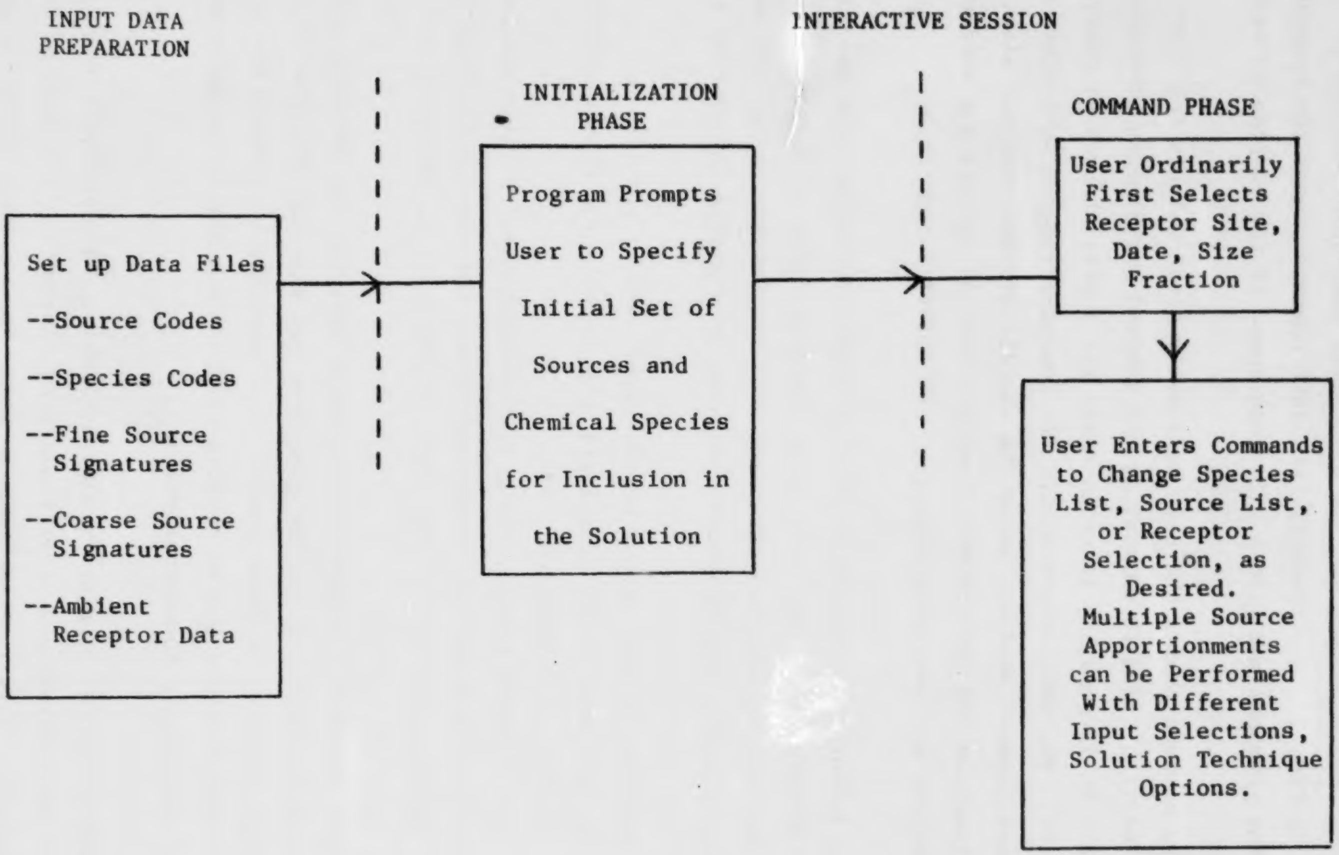
INPUT DATA PREPARATION
INTERACTIVE SESSION
INITIALIZATION PHASE
COMMAND PHASE
Set up Data Files
--Source Codes
--Species Codes
--Fine Source Signatures
--Coarse Source Signatures
--Ambient Receptor Data
Program Prompts User to Specify Initial Set of Sources and Chemical Species for Inclusion in the Solution
User Ordinarily First Selects Receptor Site, Date, Size Fraction
User Enters Commands to Change Species List, Source List, or Receptor Selection, as Desired.
Multiple Source Apportionments can be Performed With Different Input Selections, Solution Technique Options.

Figure 1-2. Conceptual Flowchart of Activities Involved in Performing Source Apportionments

information. Every command and the associated subsequent queries are discussed in Section 3. Additionally, the HELP command causes the program to list all the commands and give a brief statement of the purpose of each one.

In the command phase, the user ordinarily first selects the site, date, and size fraction (fine or coarse) of the ambient particulate concentrations to be used. It is possible later to alter the initial source or chemical species list. The CMB command causes the computer program to perform a source apportionment analysis using the current ambient receptor site, date, and size fraction and the current lists of chemical species and sources. Various options are available regarding the solution technique.

After a source apportionment is completed, additional problems can be set up by changing the site, date, size fraction, list of sources, list of chemical species, or solution technique. It is possible to perform one or a long series of source apportionment analyses in a single interactive session.

The principal output from a source apportionment consists of:

(1) an estimate of the contribution of each source to the ambient aerosol concentration, and

(2) the standard errors, i.e., the uncertainties of those estimates.

Additional statistics are also presented to aid the user in interpreting the results. Outputs from sample problems are presented in Section 4.

In some instances, source apportionment analyses are performed for the fine and coarse fractions for the same date and site and the same lists of species and sources. In these cases, it is possible to command the program to combine the fine and coarse results to produce a source apportionment of the total particulate concentration.

A post-processor program is also available. The post-processor is used to compute mean values and other summary statistics for a series of source apportionments. This feature could be used, for example, if source apportionments had been performed for a set of dates for the same site.

SECTION 2

CONCEPTUAL DISCUSSION OF SOURCE APPORTIONMENT

This section presents a conceptual discussion of source apportionment. The objective here is to provide the user with the technical background needed to use the source apportionment software. Equations are presented only to the extent that they are necessary to explain the basic concepts. The source apportionment problem is discussed in Section 2.1. The solution techniques are discussed in Section 2.2. The mathematical details are presented in Appendix D. The inputs to the computer program and the various options are presented more formally in Section 3.

2.1 Conceptual Discussion of the Source Apportionment Problem

This subsection presents a conceptual discussion of the source apportionment problem. The first step is to define the basic mass balance equation used. This equation establishes the relationship between the required inputs and the outputs and serves as a basis for further discussion.

The standard equation used in CMB analysis is as follows:

$$C_i = \sum_{j=1}^{m} F_{ij} S_j \qquad (1)$$

where

C_i is the ambient particulate concentration of chemical species i,

F_{ij} is the fraction of the particulate matter emitted from source type j comprised of species i,

S_j is the ambient particulate concentration resulting from source j, and

m is the number of sources.

The set of values F_{ij}, i=1, 2, ... , is the source signature for source j. This vector of values quantifies the chemical composition of the aerosol from that source. Suppose, for example, that the species Al, Si, K, Ca, Ti, and Ni were being used in the analysis. A small set of elements has been selected for illustrative purposes.

Also, suppose that the soil in the area being analyzed consisted of 5.6% Al, 20% Si, 1.9% K, 2.6% Ca, 0.32% Ti, and 0% Ni. Then the following would be the source signature for soil (assume that soil is source number j_o):

$$\begin{aligned} F_{1j_o} &= 0.056 \\ F_{2j_o} &= 0.20 \\ F_{3j_o} &= 0.019 \\ F_{4j_o} &= 0.026 \\ F_{5j_o} &= 0.0032 \\ F_{6j_o} &= 0 \end{aligned} \tag{2}$$

Notice that the percents have been converted to decimal fractions. The chemical species can be ordered in any way desired, as long as the ordering is the same for all signatures and for the C_i values.

The equation given above is a mass balance equation, as can be explained as follows. The right side of the equation is the sum of a set of terms of the following form: $F_{ij}S_j$. But $F_{ij}S_j$ is the ambient concentration of species i attributable to source j. This fact is illustrated through the following numerical example.

Suppose that soil accounted for 40 μg/m³ of ambient particulate matter, i.e., $S_{j_o} = 40$. From the source signature, we know that windblown dust is 20% silicon. Thus, the ambient concentration of silicon due to windblown dust is

$$(F_{2j_o})(S_{j_o}) = (0.20)(40\ \mu g/m^3) = 8\ \mu g/m^3 \tag{3}$$

Thus, the equation

$$C_i = \sum_{j=1}^{m} F_{ij} S_j \qquad (4)$$

simply states that the ambient concentration of chemical species i equals the concentration due to source one plus the concentration due to source two, etc. In other words, the basic equation used is a mass balance equation.

It is possible to add an intercept term S_o to the standard equation:

$$C_i = S_o + \sum_{j=1}^{m} F_{ij} S_j \qquad (5)$$

The term S_o is not indexed since it has the same value in each mass balance equation. The term S_o represents a discrepancy between the measured concentration C_i and the sum of its parts. If all important sources are included and there are no severe data errors, the value of S_o should be small, less than 0.05 $\mu g/m^3$ in most applications. Thus, including the term S_o simply provides a check. However, it is not required that it be included.

It is also possible to include a mass-balance equation corresponding to the total aerosol concentration C_T for the size fraction being analyzed. This equation has the form

$$C_T = S_o + \sum_{j=1}^{m} S_j \qquad (6)$$

This equation states that the aerosol concentration is the sum of the intercept and the contributions of the m sources. The intercept S_o, discussed above, is uniformly included in or excluded from all mass balance equations, including this one.

Note that the mass balance equation involving C_T has exactly the same form as the others. It can be written

$$C_T = S_o + \sum_{j=1}^{m} F_{i_T j} S_j \qquad (7)$$

where

$F_{i_T j} = 1$ for all values of j.

The quantity i_T is the value of the i index for the equation for the aerosol concentration.

The basic chemical inputs required in CMB analysis include:

(1) the vector of concentrations, C_i, i=1 to n, and C_T,

(2) the source signature matrix, F_{ij}, i=1 to n, j=1 to m, and

(3) depending on the type of statistical analysis to be performed, the standard errors of the C_i and F_{ij} values.

The unknown quantities in the CMB problem are the S_j values, j=1 to m, and the intercept S_o, if it is included.

The sample size is n+1, since there is one observation for each chemical species and one observation corresponding to C_T. Generally speaking, increasing the sample size improves the accuracy in the final results of any statistical analysis, since there is a greater opportunity for errors to balance or average out. While chemical species which serve as tracers for specific sources are generally the most helpful, species which appear in the aerosols from several sources should not be excluded. In any case, the sample size must exceed the number of quantities to be estimated, m+1 if the intercept is included and m if not. Having a larger sample size also allows more accurate estimates of the standard errors of the source contributions. As in any regression analysis, if the number of regression coefficients estimated was almost as large as the sample size, the standard errors could be artificially low and the R^2 value could be artificially high. Further discussion of the standard errors is presented below and in Appendix D.

There is no reason why all chemical species present in the ambient aerosols have to be included in the analysis. However, it is important to include all important source types. If a major source was inadvertently left out, its aerosol contribution would probably be apportioned among the sources that were included. The sources whose signatures were most similar to that of the omitted source would be increased by the greatest amount.

Within a given CMB analysis, two sources can be distinguished only if they have different source signatures. Thus, each of the m "sources" included is actually a category of sources which have the same or very similar source signatures. The categories can include natural sources, such as soil and, if appropriate, sea salt, and anthropogenic categories, such as automobiles, petrochemical plants, coal-fired power plants, cement production, etc.

A single CMB analysis alone can not differentiate among the sources within a category. For example, the aerosol contribution of cement production could be estimated, but the separate contributions of each cement facility would not be quantified. However, inferences about the effects of individual sources can be drawn in some instances from wind information. It is sometimes helpful to perform several separate analyses of cases with different wind directions.

Whenever possible, it is beneficial to subdivide source categories to produce more resolution in the final source apportionment. For example, automobiles with and without catalytic converters can be treated as two separate sources, since their aerosols are chemically different. Determining the appropriate set of source categories in a given situation can be a subtle problem. It is discussed further in the following subsection.

Another issue involves the handling of secondary aerosols. One approach is to treat secondary aerosols, especially sulfates and nitrates, as separate "sources." In the source signature for sulfate, for example, all entries would be zero except the one corresponding to SO_4, and this entry would be one; i.e.:

$$\begin{aligned} &F_{ij_o} = 0 \;, \; i \neq i_o \;, \text{ and} \\ &F_{i_o j_o} = 1 \end{aligned} \tag{8}$$

where

j_o is the source index corresponding to secondary sulfate, and

i_o is the chemical species index corresponding to SO_4.

If the elemental S concentration were used rather than SO_4, then the scheme above would be employed, except i_o would be the chemical species index corresponding to S. In the above, it is assumed that not both S and SO_4 are included in the same analysis.

In most applications, ambient concentrations are available for a series of sampling periods. There are several ways in which these data can be employed. First, a separate CMB analysis could be performed for each sampling period. This approach is beneficial if a separate source apportionment for each period is needed. Subsequently, averaging of the CMB results can be performed. In most such applications, the same source signature matrix would be used for all periods. Thus, whatever errors are present in the source signatures are common to all periods. Therefore, the separate solutions have correlated errors.

The upshot of this is as follows. Suppose a set of values S_j^1, S_j^2, ... S_j^H are obtained for S_j for H sampling periods. The value S_j^h is the aerosol contribution of source j in the h^th sampling period, $1 \leq h \leq H$. The conventional mean value $\overline{S}_j$

$$\overline{S}_j = \frac{1}{H} \sum_{h=1}^{H} S_j^h \tag{9}$$

is an unbiased estimate of the average aerosol contribution of source j during the study period. However, the conventional standard error of the mean

$$s_m = \left[\frac{1}{H(H-1)} \sum_{h=1}^{H} (S_j^h - \overline{S}_j)^2 \right]^{\frac{1}{2}} \tag{10}$$

is low-biased due to the correlated errors in the individual S_j^h values.

The regression analysis for period h produces the estimate S_j^h and the corresponding standard error s_{jh}. Another approach is to use error propagation techniques to compute the standard error of $\overline{S}_j$ in terms of the s_{jh} values, $1 \leq h \leq H$:

$$s'_m = \frac{1}{H} \left[\sum_{h=1}^{H} s_{jh}^2 \right]^{\frac{1}{2}} \tag{11}$$

However, this approach fails for the reason discussed above. The quantity s'_m would be an unbiased estimate of the standard error of $\overline{S}_j$ if the errors in the individual S_j^h values were independent. Due to the positively correlated errors, however, s'_m has a low bias.

There is an alternative method for obtaining the average contributions of the different sources and the corresponding standard errors. The approach involves averaging the concentrations of each C_i and C_T separately, just as the S_j^h values are averaged above. Then a single CMB analysis can be performed for the entire study period using the averaged concentrations. The standard errors of the results will be produced by conventional regression analysis procedures. These standard errors will not be affected by the correlated error problem discussed above.

It is also possible to average data in groups and perform a separate CMB analysis for each group. For example, in a given application, one might average all data taken at sites downwind of a given city when the wind was persistently from the north. The groups are usually selected on the basis of meteorological conditions and spatial relationships.

2.2 Conceptual Discussion of Statistical Solution Techniques in CMB Analysis

This subsection presents a conceptual discussion of the solution techniques available for CMB analysis. The basic approach employed in the computer program documented herein is regression analysis. However, several additional features are also provided to handle specific aspects of the problem. These features include the following:

(1) Weighted least squares--a modification of conventional regression in which the more accurate concentration data are weighted more heavily to produce a better solution. Weighted least squares is a standard feature of the program, not an option.

The following two features are options:

(2) Effective variance calculations--a modification of weighted least squares in which the uncertainties in the source signatures as well as the uncertainties in the concentration data are taken into account.

(3) Ridge regression--a technique designed to handle cases with similar source signatures.

It is possible to select either option (2) or (3), both of them, or neither.

The discussion of the statistical methods presented here is designed to help the user select the appropriate method for his problem. The mathematical details are given in Appendix D.

The basic CMB equations

$$C_i = S_o + \sum_{j=1}^{m} F_{ij} S_j \qquad (12)$$

are linear in the S_j values. Thus, a solution could be obtained through linear regression analysis. In the terms of regression analysis, the C_i's are the values of the dependent variable, F_{ij} is the i^{th} value of the j^{th} predictor variable, S_o is the intercept, and S_j is the j^{th} regression coefficient.

The solution by conventional least squares is accomplished by choosing S_o and the S_j values to minimize the sum of squares of the differences between the left and right sides of the mass balance equation above:

$$\sum_i (\hat{C}_i - C_i)^2 + (\hat{C}_T - C_T)^2 \tag{13}$$

where

$$\hat{C}_i = S_o + \sum_{j=1}^{m} F_{ij} S_j \tag{14}$$

and

$$\hat{C}_T = S_o + \sum_{j=1}^{m} S_j \tag{15}$$

i.e., $\hat{C}_i$ and $\hat{C}_T$ are the estimated or calculated concentrations, and C_i and C_T are measured concentrations.

In conventional least squares, all data are weighted equally in the calculations. This is acceptable if the uncertainties of all the data are about the same. In weighted least squares, the more accurate data are weighted more heavily to produce a more accurate solution. In weighted least squares, S_o and S_j values are selected to minimize the following:

$$\sum_i \frac{(\hat{C}_i - C_i)^2}{s^2_{C_i}} + \frac{(\hat{C}_T - C_T)^2}{s^2_{C_T}} \tag{16}$$

where

s_{C_i} is the standard error of C_i, and

s_{C_T} is the standard error of C_T.

Weighted least squares employs the uncertainties of the concentration data only. However, the source signature data also have uncertainties. It is possible to account for these uncertainties also by using effective variances (Watson, 1979). The mass balance equation

$$C_i = S_o + \sum_{j=1}^{m} F_{ij} S_j \tag{17}$$

can be rewritten

$$C_i - S_o - \sum_{j=1}^{m} F_{ij}S_j = 0 \qquad (18)$$

The effective variance $s^2_{EV_i}$ for this equation is the variance of the entire left side of the final equation, including the effects of the errors in C_i and F_{ij}, j=1 to m. The exact expression for the effective variance is given in Appendix D. The main point is that the effective variance is an estimate of the total uncertainty in an equation, taking into account the errors in all input data in the equation.

After the effective variances are calculated, S_o and the S_j values are selected to minimize the following:

$$\sum_i \frac{(\hat{C}_i - C_i)^2}{s^2_{EV_i}} + \frac{(\hat{C}_T - C_T)^2}{s^2_{EV_T}} \qquad (19)$$

Thus, the effective variance approach involves a weighted least squares analysis but uses refined estimates of the weights.

Appendix D shows that calculation of the effective variances requires estimates of the S_j values, and the S_j values are computed in terms of the effective variances. For this reason, an iterative solution is required if effective variances are used.

Before discussion of the third feature, ridge regression, a few comments will be made about the input standard errors. If blank values were entered for the standard errors of either the ambient concentrations or the source signatures, zeroes would be stored. A weighted regression analysis cannot be performed using species whose concentrations have zero standard errors. If an attempt is made to do such an analysis, the program will print a message and abort that particular source apportionment. Nonzero standard errors are not required, however, for species used only to compare observed and predicted concentrations but not used in the regression analysis (see Section 3).

The standard errors for the source signatures are used only if the effective variance feature is selected. Zero values for these standard errors would not prevent the analysis from being performed. Moreover, a zero standard error could be correct in some cases. For example, it could be known that a given species was absent from the aerosols from a particular source. Then the signature entry for that source and chemical species would be zero with a standard error of zero.

However, if some zero standard errors were present due to blanks which were entered only because the standard errors were not known, inaccuracies could result. The source signature entries with zero standard errors would be treated as if they were known exactly, while the entries with nonzero standard errors would be treated as having random errors. Thus, the weighting of the data would not be in accordance with the actual uncertainties. As a result, the final results would have larger uncertainties than if the weighting had been performed correctly. The increase in the uncertainties might not be reflected in the calculated standard errors of the final results. If all entries for the source signatures had zero standard error entries, use of the effective variance option would not change the final answers. The only effect of using effective variances in this case would be to increase the computer time somewhat.

The third feature which can be added to the solution technique is called ridge regression analysis. Ridge regression is an advanced statistical technique which is useful when two or more sources have similar signatures. Clearly, if two sources had identical signatures, their contributions to the ambient aerosol could not be separated through CMB analysis. If the signatures were similar but not identical, separation would be possible but difficult to accomplish accurately. The problem is referred to as "multicollinearity." Stated more generally, multicollinearity exists when any source signature is nearly a linear combination of any subset of the other signatures.

The effect of multicollinearity is to cause large random errors in the estimates of the S_j if conventional techniques are used. If severe multicollinearities are present, it is even possible to obtain negative S_j values with large magnitudes.

The variance inflation factor is a convenient measure of the effects of multicollinearity in a given problem. The variance inflation factor VIF_j is defined as follows:

$$VIF_j = \frac{var\ (S_j)}{var^1\ (S_j)} \qquad (20)$$

where

$var\ (S_j)$ is the error variance of S_j if it is calculated through conventional regression techniques, and

$var^1\ (S_j)$ is the error variance S_j would have had in the absence of multicollinearity.

Thus, VIF_j is the increase in the uncertainty (error variance) of S_j due to the effect of multicollinearity alone. If S_j was not affected by multicollinearity at all, VIF_j would be one. If VIF_j was near one, say between one and 1.5, one could say that the effect of multicollinearity on S_j was relatively small. Suppose, however, that VIF_j was 100. This would mean that the error variance of S_j was increased by a factor of 100, and the standard error of S_j was increased by a factor of 10, by the effect of multicollinearity alone. It is beneficial to examine the variance inflation factors in each problem to determine whether multicollinearity is a serious factor.

Factor analysis and principal component analysis are additional statistical methods which can be used to analyze the multicollinearities in a given data set. While these methods are outside the scope of this report, they are discussed by Morrison (1967) and other writers on multivariate statistical methods.

If multicollinearities are present, there are basically two approaches. One approach involves first identifying the sources whose signatures are collinear; soil, road dust, and asphalt production ordinarily form such a set. Then one of the sources can be chosen to represent each set. In the example given, this would mean that the combined contribution of soil, road dust, and asphalt production to the ambient aerosol levels would be estimated, but their individual contributions would be unknown. Some combining of sources into categories is usually necessary. However, the greater the number of separate source categories, the greater the resolution is in the source apportionment.

The second approach is to employ ridge regression, a technique which is designed to handle cases affected by multicollinearity. In ridge regression, the goal is to introduce a small bias into the solution in order to achieve a large reduction in the random error, so that the total error (bias plus random error) is reduced.

In ridge regression a parameter k is introduced. The exact mathematical definition of k is given in Appendix D. The important point is that as k increases, the random error decreases and the bias error increases. The objective, then, is to pick a value of k near the optimum, where the total, or bias plus random, errors are minimal. The program computes the solutions for a set of values of k. At the user's option, the program will select a value of k according to criteria given in Appendix D. The user also has the option of displaying the solutions for the complete set of values of k.

The value k=0 is included in the set. When k=0, the ridge solution is the same as the conventional least squares solution. If this is the best solution according to a specified set of criteria, it can be selected. Thus, using the ridge feature does not prevent the conventional least squares solution from being used, but it allows an additional set of solutions to be considered.

There is presently not an algorithm which guarantees selection of the optimal k value. When multicollinearities are present, the regression coefficients are typically extremely sensitive to k for small values of k. However, as k increases, the coefficients stabilize. Hoerl and Kennard (1970a, b) suggest choosing k from within the stable region, where moderate changes in k do not affect the coefficients significantly. Thus, slight deviation from the optimal k would not cause serious errors.

There is no simple formula which tells the user when sources should be combined into one category and when their separate aerosol contributions should be estimated. However, the variance inflation factor, discussed above, is an objective measure which tells the user which sources are affected by multicollinearity and to what extent.

One rule of thumb which can be used is to determine whether the signatures of two sources differ more than their uncertainties. Theoretically, a significant difference for only one chemical species would be sufficient to allow the user to separate the influences of the two sources. Also, the user should remember that, generally, random errors tend to balance or "average out" in a statistical analysis. Thus, if two source signatures were different by about the uncertainty level for each of several species, it is possible that meaningful separation of the sources could be achieved. The use of as many species as possible in the analysis allows the maximum opportunity for the error averaging effect to occur.

Another approach is to perform different source apportionment analyses with different levels of source resolution and then compare the results. For example, in one analysis, soil and road dust could be combined into a "crustal" source, and in a second analysis they could be treated separately. If the estimates of the separate aerosol contributions for soil and road dust were physically unreasonable or had excessively large standard errors even when the ridge regression was used, this would indicate that the two sources should be combined. However, if the estimates of their separate contributions were physically reasonable and had acceptably small standard errors, then they should probably be treated as two sources. The standard errors of the two separate sources in one analysis should be compared to the standard error for the crustal source in the other.

Regarding the performance of ridge regression, in a survey article on the subject, Vinod (1978) states the following:

> Readers of this review are familiar with multicollinearity problems, discussed by Farrar and Glauber (1967), Leamer (1973), and others. Hoerl and Kennard's (1970a, b) ridge regression (RR) offers new hope for avoiding most serious ill-effects of multicollinearity on ordinary least squares (OLS) regression coefficients. These include "wrong signs," drastic changes in regression coefficients after minor data revision or omission of one or two observations, and conflicting conclusions from usual significance tests.
>
> In Monte Carlo experiments the true regression coefficients are specified. The data structure is usually chosen from a real life regression problem. Random numbers are used to create hundreds of "typical" regression problems. The estimated regression coefficients using RR and OLS are compared in terms of mean-squared error (MSE), i.e., the average squared Euclidian distance between the estimate and the parameter. In the following independent studies by investigators from diverse fields, the superiority of RR over OLS [ordinary least squares] is almost always noted; although there is wide disagreement about the "optimum" RR method.

In support of the statements above, Vinod subsequently references sixteen published Monte Carlo studies and refers to "many unpublished dissertations." Selection of the optimum RR method is discussed above.

The quotation above was chosen from the extensive literature on ridge regression because (1) it appears in a survey article and summarizes results from many independent studies and (2) the results to which Vinod refers are objective in nature, being comparisons of true and estimated regression coefficients in Monte Carlo studies. However, no single quotation could represent all opinions expressed in the literature. In the following quotation, Draper and Smith (1981) present another view regarding the simulation results. They use the letter "θ" to denote the ridge parameter, referred to as "k" here.

> ### Ridge Regression Simulations--A Caution
>
> A number of papers containing simulations of regression situations claim to show that ridge regression estimates are better than least squares estimates when judged via mean square error. Such claims must be viewed with caution. Careful study typically reveals that the simulation has been done with effective restrictions on the true parameter values--precisely the situations where ridge regression is the appropriate technique theoretically. The extended inference that ridge regression is "always" better than least squares is, typically, completely unjustified.
>
> ### Summary
>
> From this discussion, we can see that use of ridge regression is perfectly sensible in circumstances in which it is believed that large β-values are unrealistic from a practical point of view. However, it must be realized that choice of θ is essentially equivalent to an expression of how big one believes those β's to be. In circumstances where one cannot accept the idea of restrictions on the β's, ridge regression would be completely inappropriate.
>
> Note that, in many sets of data, where the sizes of the least squares estimates are acceptable as they are, the ridge trace procedure would result in a choice of $\theta = 0$. A value of $\theta \neq 0$ would be used only when the least squares results were not regarded as satisfactory.
>
> There is a large and growing literature on the many aspects and generalizations of ridge regression; some selected references are given at the end of the book.

> OPINION. Ridge regression is useful and completely appropriate in circumstances where it is believed that the values of the regression parameters are unlikely to be "large" (as interpreted through σ_β^2 or c^2 above). In viewing the ridge traces, a subjective judgment is needed which either (1) effectively specifies one's Bayesian prior beliefs as to the likely sizes of the parameters, or (2) effectively places a spherical restriction on the parameter space. The procedure is very easy to apply and a standard least squares regression program could easily be adapted by a skilled programmer. Overall, however, we would advise against the indiscriminate use of ridge regression unless its limitations are fully appreciated. (The reader should be aware that many writers disagree with our somewhat pessimistic assessment of ridge regression.)

Draper and Smith have indicated that ridge regression is "perfectly sensible in circumstances in which it is believed that large β-values [regression coefficients] are unrealistic from a practical point of view." They also say that "In circumstances where one cannot accept the idea of restrictions on the β's, ridge regression would be completely inappropriate." Recall from the discussion above that the regression coefficients are the estimates of the source contributions.

The question, then, is whether a priori knowledge exists in source apportionment applications which would allow coefficients with unreasonably large magnitudes, if present, to be identified. The answer to this question is yes. Consider the case in which the signatures of two or more sources are collinear. Typically, if conventional weighted least squares is used, one of the collinear sources will have a large positive error, and another source will have a counterbalancing negative error with large magnitude. The large errors cause the regression coefficients with large magnitudes referred to by Draper and Smith. The following are two useful criteria for identifying this situation in source apportionment applications:

(1) In extreme cases, one of the estimated source contributions may exceed the aerosol concentration for the size fraction being analyzed. The existence of an upper bound for contributions from individual sources provides one criterion for identifying

excessively large coefficients. To be conservative one could use the aerosol concentration plus three times its standard error as the upper bound.

(2) If multicollinearities are present, the counterbalancing negative errors mentioned above can cause negative estimates of some source contributions. If negative estimates with large magnitudes were present, the solution would clearly be physically unreasonable.

Thus, both an upper bound (the aerosol concentration for the size fraction being analyzed) and a lower bound (zero) exist for the regression coefficients. If either of these bounds was significantly exceeded, the solution should be considered unreasonable. Source apportionment, then, is a context in which criteria exist for recognizing unreasonably large regression coefficients. Thus, according to Draper and Smith's discussion, ridge regression should be considered a useful tool in source apportionment applications. The authors of this report feel that the use of ridge regression in a given problem can also be justified on other grounds, such as the presence of large variance inflation factors and sensitivity of both the regression coefficients and their standard errors to k, especially for small values of k.

However, Draper and Smith are right that ridge regression should not be used indiscriminately, as if its application would automatically eliminate all problems caused by multicollinearity. As is indicated by both articles, it cannot be guaranteed that ridge regression will produce a better solution in every application than does conventional least squares. It should also be remembered, however, that use of the ridge option does not prevent selection of the solution for k=0 if this solution is the best. The solution for k=0 is equivalent to the weighted least squares solution.

SECTION 3

GUIDE TO USE OF INTERACTIVE SOURCE APPORTIONMENT SOFTWARE

This section discusses the procedures required to use the interactive source apportionment software. One or more source apportionment analyses can be performed in a single interactive session.

There are three types of inputs to the CMB program:

Data Files
Commands
Responses to Queries

The data files, which contain the source signatures, ambient concentration data, and other information, must be set up before an interactive session is begun. Commands and responses are entered interactively. The user may enter any of the allowed commands following the prompt "ENTER COMMAND." Responses to queries are the user replies to specific questions or data requests from the CMB program.

There are five input data files that are required by the program:

List of Source Codes
List of Species Codes
Source Signature Matrix (Fine Particulate Fraction)
Source Signature Matrix (Coarse Particulate Fraction)
Receptor Concentration Data

A certain degree of incompleteness is possible. For example, if only fine fraction data are available for source signatures, an empty data file is acceptable for the coarse fraction.

An interactive session with the CMB program consists of two phases: an initialization phase and a command phase. The program controls the initialization phase by prompting the user for the initial sources and species. The user may add or delete sources and species for either size fraction in the working phase. The user controls the command phase by issuing commands. The command may be performed immediately or the CMB program may prompt the user for additional information before proceeding. The user must spell out the command in full. However, responses to prompts from the computer may be abbreviated by the first letter of the response unless a numerical value or alphanumeric code (site code) is requested. For example, a "Y" has the same effect as "YES." In fact, the program reads only the first letter of nonnumeric, non-code responses. Thus, "SOURCE SIGNATURE" can be abbreviated "SOURCE" or "S."

In the following subsections, discussions are presented on the following:

(1) required data files,
(2) initialization phase of the interactive session,
(3) command phase of the interactive session,
(4) formats of required data sets,
(5) command reference summary, and
(6) computer system considerations

3.1. Description of Data Files

The CMB program requires 11 files for input or output. These include data input files, hardcopy printout files, interactive communications, and temporary data storage files. These files are accessed by the CMB program according to the following FORTRAN Input/Output unit numbers:

Unit #	Purpose	I/O
2	Source Names/Codes	Input
3	Species Names/Codes	Input
5	Interactive Read	Input
6	Interactive Write	Output
7	Fine Fraction Signature	Input
8	Coarse Fraction Signature	Input
9	Hardcopy Print (Summary)	Output
10	Temporary Storage	Input/Output
11	Hardcopy Print (General)	Output
12	User-Followup Data	Output
13	Receptor Concentrations	Input

The user's terminal serves as the interactive read and write units. The user's commands and replies are read and the program's queries and output are written. The program output includes the fitted CMB coefficients and predicted concentrations. Sections 3.2 and 3.3 describe the commands, queries and replies. Section 4 presents an annotated interactive session.

3.1.1 Input Data Files

There are five input data files that must be available to the program before an interactive session can begin. The purpose and content of each data file are described below. The detailed record formats are given in Section 3.4, and examples are given in Appendix C.

The source and species names are for the convenience of the user. The source and species codes must be consistent across all data sets. These codes are used for labeling the data sets only. During the interactive session the program will assign source and species numbers that may not agree with the source and species codes. The source and species numbers, not the codes, must be used in the interactive session. The source and species numbers can be listed at the beginning of the interactive session. The source and species codes and numbers, the source signature matrix, and the current receptor concentrations can be listed with the PMATRIX command during an interactive session.

The following are descriptions of the required input files:

Source and Source Code List--Eight-character source names and two-digit source codes are required. The source signature matrix must be coded consistently with this list. The two-digit codes may range from "01" to "99" in any order. Gaps are allowed in the code range. Sources not used in the current source signature matrix can be present. The maximum number of sources which can be included in the input data files is 35.

The maximum number of sources which can be included in a given CMB analysis, however, is 16.

Species and Species Code List--Eight-character species names and two-digit species codes are required. The source signature matrix and the receptor concentrations must be coded consistently with this list. The same comments made for source codes apply here. The maximum number of species which can be included in the input data files is 35. The maximum number of species which can be used in a given CMB analysis is 21.

Fine Fraction Source Signature Matrix--The fraction of the aerosols from each source accounted for by each species is required. If the effective variance method is to be used, the standard error of each item is also required. Each item and its standard error are entered on a separate line (record or card) along with the identifying source and species codes.

Coarse Fraction Source Signature Matrix--The same comments as for the fine fraction apply here.

If coarse fraction data are not available, a dummy data set may be substituted.

Receptor Concentration Data--The receptor concentration and its standard error are required for each species for both fine and coarse fractions. Alternatively, the fine fraction and total aerosol may be substituted and the program will calculate the coarse fraction data. Each species is coded on a separate line (card or record).

If only fine fraction data are available the coarse fraction may be coded as zero.

3.1.2 Output Data Files

The CMB program writes to three permanent files: the general hardcopy, the summary hardcopy, and the user followup data file. The two hardcopy files are for printed results (132-character line). The postprocessor data file makes certain input and output data available for further processing. Examples are given in Appendix C.

General Hardcopy--The general hardcopy printout includes hardcopy versions of results displayed in the interactive sessions. Some additional calculated values are presented that are not included in the terminal displays. The primary output to the general hardcopy is the display of CMB coefficients with measured and calculated concentrations. Appropriate standard errors, percentages, and ratios are included. This output results from a WRITE command.

Certain other commands can direct results to the general hardcopy. The PMATRIX command prints input matrices. The PSOLN command prints ridge regression solutions. The PCOMP command prints averages of source contributions.

Summary Hardcopy--The summary hardcopy printout tabulates the CMB coefficients for fine, coarse and total fractions. Standard errors and percent composition are included. This report is printed by the WRITE command only when both fine and coarse fractions are analyzed for the same site and date.

User Followup Data File--The user followup data may be used for further analysis with user-written software. The calculated concentration of each species contributed by each source is written to this file. The program writes these values to the file by the WRITE command only when both fine and coarse fractions are analyzed for the same site and date (as with the summary hardcopy). The measured concentrations are also placed on the file. The detailed format of the data file is given in Section 3.4.

3.2 Initialization Phase of an Interactive Session

The initialization phase consists of a series of queries and prompts from the program that require responses from the user. Most of the required responses are to identify the sources and species. Each query is given below followed by a discussion of the appropriate user response.

```
WOULD YOU LIKE TO LOOK AT THE SOURCE AND SPECIES LISTS?
```

Unless the user is familiar with the program and data, he should reply "YES." If the user responds "YES" the program lists the sources and species by number and name at the terminal. In other parts of the session the user will be asked what sources or species he wants to add, delete, or display. The user must respond with the source or species number according to these lists. Generally, the program will display the source or species number along with the name whenever it appears.

```
PLEASE INPUT INITIAL FITTING INFORMATION
INITIAL SOURCE   1: XX
```

At this point the user tells the program which sources to include in the initial problem set. The user should key in the desired source numbers, one line at a time in response to the program prompts, "INITIAL SOURCE 1: XX," "INITIAL SOURCE 2:XX," and so forth. When all of the desired sources have been entered, the user should reply with a blank or null line (carriage return with no data).

If the user wants all the available sources in the initial problem set, he should enter "-1" and the program will automatically include them up to its limit, which is 16. The user can also use this feature to save time when almost all sources are wanted. The DS (Delete Source) command can be used later to remove unwanted sources.

```
PLEASE INPUT SPECIES
INITIAL SPECIES  1:XX
```

At this point the user tells the program which sources to include in the initial problem set. The above discussion for entering initial sources applies also to species. The DE (Delete Species) command can be used later to remove unwanted species.

```
ARE INITIAL SOURCES AND SPECIES CORRECT?
```

If the user responds "YES," then the session enters the command phase. The program responds with "ENTER COMMAND" (see below). If the user responds "NO," then he is prompted with the following query:

```
USE COMMANDS AE, DE, AS, DS FOR CHANGES.
OR, DO YOU WANT A FRESH START?
```

Both fine and coarse size fractions will start with the initially chosen sources and species. The user can use the add and delete commands to change the list of sources and species for either size fraction. Later the user can restore either size fraction to the initially chosen sources and species. A "YES" response to this query returns the session to "PLEASE INPUT INITIAL FITTING INFORMATION" to re-enter the initial choice of sources and species. A reply of "NO" gets the following prompt:

```
THE HELP COMMAND LISTS COMMANDS
SIZE IS FINE
ENTER COMMAND
```

The session has entered the command phase. This phase is discussed in the next section. The size fraction is currently set to "fine."

3.3 Command Phase of an Interactive Session

The command phase of the CMB program is indicated by the prompt "ENTER COMMAND." Each command is invoked by entering its name in the keyboard. For some commands this is all that is necessary. Other commands will prompt the user for additional information.

During the command phase many parameters remain set at previous values until changed by the user. This feature relieves the user from the repetitive entries that would otherwise be necessary. The parameters that hold their values and the commands that change them are the following:

Parameters	Commands to Change
List of Sources	AS, DS, INITIAL
List of Species	AE, DE, INITIAL
Receptor Concentrations	SELECT, AUTOFIT
Size Fraction	SIZE, SELECT, AUTOFIT
Background	BACKOUT, BACKIN

The command "PINFO" will display the current status of these parameters.

3.3.1 HELP

The HELP command lists all the commands with a brief statement of the purpose of each one.

3.3.2 SELECT

The SELECT command is used to select the receptor data for the current problem. SELECT also automatically invokes commands CMB and PDATA. Under normal use, SELECT will be the first command of the interactive session.

SELECT will prompt the user to identify the receptor data as follows:

```
ENTER DESIRED CMB SITE CODE:  XXXXXXXXXXXX
```

The user should respond with the site code or name. If the sites available are not known, enter a "?" or "Q" and then give blank responses to the next three queries. The program will list the available receptors and dates for which data are available. Subsequently, the user can use the SELECT command again and choose a site and date from those listed.

```
ENTER YEAR:  YY
```

Key in the last two digits of the desired year.

```
ENTER DATE:  MMDD
```

Key in the month and day numbers of the desired sampling date. For example, June 26 is 0626.

```
INPUT DESIRED SIZE FRACTION:  (FINE OR COARSE)
```

Key in FINE for the fine fraction or COARSE for the coarse fraction.

The CMB program will now search the receptor concentration data set for the desired data. As it does so it will display the cases it encounters in the search. At the far right will be the letters FC for Fine/Coarse data type or FT for Fine/Total data type. The portion not present will be calculated.

The program then begins the CMB command followed by PDATA.

3.3.3 CMB

The CMB command performs the analysis. It also prompts the user for the various method options. The method options are:

Weighted Ridge Regression/Weighted Least Squares
Effective Variance Method/No Effective Variances
Fitted Model Intercept/Zero Intercept

These options may be exercised in any combination.

```
DO YOU WANT RIDGE SOLUTIONS?
```

Reply "YES" for weighted ridge regression or "NO" for weighted least squares. (Reply "SAME" for the same method options chosen in the previous use of the CMB command. The program will then proceed directly to the analysis without further queries.) If the reply is "YES" then the following two queries will be presented:

```
CMB WILL SELECT THE BEST RIDGE SOLUTION
DO YOU WANT TO SEE A SUMMARY OF THE OTHERS?
```

A "YES" response will cause the program to display the following items for each ridge k-value: R^2, calculated total aerosol (sum of coefficients), negative coefficient of greatest magnitude, the number of negative coefficients, and the number of iterations. If the effective variance option is not used, the number of iterations is always one.

IN THE SELECTION OF THE BEST RIDGE SOLUTION, WHAT WEIGHT DO YOU WANT? (DEFAULT = 1.0)

In the selection of the best ridge solution two criteria are considered: closeness of the calculated aerosol total to the measured aerosol total and the smallness in magnitude of any negative coefficients. These two criteria are weighted in choosing the best solution. A weight of 1.0 gives an "even" weight to the two criteria. A weight less than 1.0 gives more weight to the closeness of the total aerosol calculated and measured values. A weight greater than 1.0 gives more weight to the smallness in magnitude of any negative coefficients. The mathematical details for the selection of the ridge solution are discussed in Appendix D.

Key a null line (press return) for the default weight 1.0. Otherwise, enter a number above zero but less than ten million. The decimal point must be keyed.

DO YOU WANT TO USE EFFECTIVE VARIANCES?

A "YES" reply will invoke the effective variance method. Standard errors must be present on the source signature matrix. Reply "NO" if the effective variance method is not desired.

DO YOU WANT TO INCLUDE THE INTERCEPT IN THE MODEL?

A "NO" reply sets the intercept to zero. A "YES" reply allows the program to fit the intercept to the data. A fitted intercept value greatly different from zero is an indicator of difficulties. This may result from an important source being omitted or data errors.

The CMB program now performs the analysis. If the effective variance and ridge options are in effect, the following prompt may occur, particularly for the first ridge k-value (zero or least squares):

```
XXX ITERATIONS SO FAR FOR RIDGE K = X.XXX WITHOUT CONVERGENCE.  HOW MANY
MORE DO YOU WANT TO TRY?
```

If the effective variance option is in effect but the ridge option is not, the following prompt may occur:

```
XXX ITERATIONS SO FAR WITHOUT CONVERGENCE.  HOW MANY MORE DO YOU WANT TO TRY?
```

Reply with the number of extra iterations. Generally, just a few more are required (less than 10). If no more iterations are wanted key a zero, and the solution will be the current estimate.

The program now enters the PDATA command automatically.

3.3.4 PDATA

The PDATA command displays the problem solution at the user's terminal. The output consists of the solution coefficients and standard errors. The least squares solution is automatically printed along with variance inflation factors. This means that the same solution will be given twice if the ridge regression option is not used.

Optionally, the actual and calculated receptor concentrations will be displayed:

```
PRESS RETURN TO CONTINUE OR ENTER C FOR NEXT COMMAND
```

A null line (press the transmit or enter key) will result in the optional receptor concentration display. Key in a C if this information is to be suppressed.

The output from PDATA can be sent to hardcopy with the WRITE command.

3.3.5 WRITE

The write command writes the solution and other information to storage files for later use or display. The files to which data are written are:

General Hardcopy
Summary Hardcopy
User Followup Data, and
Temporary Storage for use by the PCOMP command.

The hardcopy files may be printed at the user's terminal or on the system printer after the end of the CMB interactive session. Section 3.6 discusses access to these files.

The report written to the general hardcopy is an expanded version of the terminal display given by the PDATA command. The report written to the summary hardcopy is a summary of these reports for fine, coarse and total sizes. The items written to the user followup data file are contributions from each source to the calculated concentration of each species.

The WRITE command writes the current CMB analyses results to the general hardcopy file. This is confirmed at the user's terminal by the message "WRITTEN." The WRITE command writes to the summary hardcopy, the user followup data, and the temporary storage only under the following conditions: both fine and coarse CMB analyses are performed in succession and each is followed by a WRITE command. The same site and date must be used for both size fractions. This occurrence is confirmed at the user's terminal by two successive "WRITTEN" messages. A CMB analysis display for the total of the fine and coarse fractions is also written to the general hardcopy at this time.

Section 3.1.2 discusses the contents of the three output files. Section 3.4 gives the format of the user followup data file. Appendix C gives examples of the output to these files. A flow diagram illustrating the WRITE command is given in Appendix B.

3.3.6 SIZE

The SIZE command changes the size fraction from the current setting to the other. (The two alternatives are fine and coarse.) The command then displays the new current size fraction.

3.3.7 AE

The AE command is used to add species to the current working list. The program prompts the user for species to add. The user responses are checked for validity. After the AE command is made, the user is prompted with the following:

```
SIZE IS XXXXXX
INPUT CODE OF ADDED SPECIES
```

The user should reply with the species number. The program will then issue the prompt again and another species may be added. When all species desired are added, give a blank or null line (press transmit or enter).

If the entry is invalid or unintelligible the program will print a message and issue a new prompt.

If the current size fraction displayed is not the desired one, then the user should terminate the command (enter a blank line), give the SIZE command, and re-enter the AE command.

3.3.8 DE

The DE command is used to delete species from the current working list. The program prompts the user for species to delete. The user responses are checked for validity. After the DE command, the user is prompted with the following:

```
SIZE IS XXXXXX
INPUT CODE OF DELETED SPECIES
```

The user should reply with the species number. The program will then issue the prompt again and another species may be deleted. When all species desired are deleted, give a blank or null line.

If the entry is invalid or unintelligible the program will print a message and issue a new prompt.

If the current size fraction displayed is not the desired one, then the user should terminate the command (enter a blank line), give the SIZE command, and re-enter the DE command.

3.3.9 AS

The AS command is used to add sources to the current working list. This command functions similarly to AE.

3.3.10 DS

The DS command is used to delete sources from the current working list. This command functions similarly to DE.

3.3.11 INITIAL

The INITIAL command restores the current size fraction source and species lists to the initially chosen lists. The initial lists were chosen in the initialization phase.

3.3.12 PSOLN

The PSOLN command displays all 31 ridge regression solutions. The display may be directed to the user's terminal or to hardcopy.

The output from this command can be extensive. The program first warns the user by giving the size of the entire solution set. Then the program prompts the user as follows:

```
ARE YOU SURE YOU WANT TO LOOK AT THESE NUMBERS?
```

Reply "YES" if still serious. A "NO" will get the prompt ENTER COMMAND.

```
DO YOU WANT THE SOLUTIONS PRINTED ON THE HARDCOPY? (INSTEAD OF YOUR
TERMINAL)
```

This option allows the user to get the 31 solutions and examine them later. A "YES" response sends the solutions to hardcopy. A "NO" response will display them at the user's terminal.

```
CAN YOUR TERMINAL DISPLAY A 132 CHARACTER LINE?
```

Some printer terminals can print a wide 132-character line. Other printer terminals and some CRT's display a 72-character line. On these terminals a 132-character line will "wrap around" and be difficult to read. The program will format the line to either a 132 or a 72-character line, depending on the user response.

3.3.13 PMATRIX

The PMATRIX command displays the source signature matrix, a single source signature, the receptor concentrations, or the source and species codes. The displays may be directed to the user's terminal or to hardcopy.

```
MATRICES CAN GO TO HARDCOPY
DO YOU WANT THEM DISPLAYED AT YOUR TERMINAL INSTEAD?
```

A "NO" will send all output to hardcopy. Nothing will be displayed at the user's terminal. A "YES" will result in all output being displayed at the terminal. The command can be re-entered later to redirect output.

```
WHAT DO YOU WANT TO SEE?
SOURCE SIGNATURE, RECEPTOR CONCENTRATIONS, OR CODES?
OR ARE YOU DONE?
```

A reply of DONE or a null line will bring the prompt ENTER COMMAND. Otherwise, reply "SOURCE" or "RECEPTOR" or "CODES." The reply "CODES" will display the source and species numbers and input data set codes. The reply "RECEPTOR" will display the receptor concentrations for both fine and coarse size fractions. The reply "SOURCE" will result in the following prompt:

```
WHAT SIZE FRACTION? (FINE OR COARSE)
```

Reply FINE for fine fraction source signature data or COARSE for coarse fraction source signature data.

```
DO YOU WANT TO LOOK AT THE WHOLE MATRIX?
```

The program will warn the user of its dimensions. A "NO" response will allow the user to select individual source signatures for display. A "YES" response will result in the following query (if output is directed to user's terminal):

```
CAN YOUR TERMINAL DISPLAY A 132 CHARACTER LINE?
```

The program will adjust the format to fit either a 72 or 132-character line. See PSOLN command for details.

The source signature matrix is displayed so that the standard error is directly below each matrix item.

If the option to display individual source signatures was selected, the program prompts,

WHICH SOURCE DO YOU WANT?

Key in the source number. The program will display the indicated source data. The prompt will then be reissued. Another source may be displayed, or enter a blank or null line to be returned to the prompt WHAT DO YOU WANT TO SEE?

3.3.14 PINFO

The PINFO command displays the current status of the problem-solving process. This is more useful for CRT users than those with printer terminals.

The command displays the sources and species currently assigned. It also gives the receptor identifier, data, size fraction, and background information. An example of the display appears in Section 4.

3.3.15 AUTOFIT

The AUTOFIT command is an alternative to the SELECT command. The SELECT command selects a single receptor site, date, and size fraction for CMB analysis. In contrast, the AUTOFIT command automatically sequences through a series of sites, dates, and size fractions. The AUTOFIT command is equivalent to a series of SELECT and WRITE commands. However, user responses are minimized by eliminating repetitive keying of commands and responses.

Before using the AUTOFIT command, the user should be familiar with the SELECT command. Like SELECT, the AUTOFIT command invokes the CMB and PDATA commands. It also invokes the WRITE command.

Like the SELECT command, the AUTOFIT command queries the user for site, year, and date. This determines the initial receptor. AUTOFIT does not prompt the user for size fraction because it will do both size fractions. The AUTOFIT sequence next invokes the CMB command and queries the user for the analysis method (ridge regression, effective variance, and intercept options). The method chosen will be used for all receptors and both size fractions in the AUTOFIT series.

The AUTOFIT series begins with the fine fraction of the chosen initial receptor site and date. Then the coarse fraction is analyzed. These analyses are repeated on the next receptor site and date of the Receptor Concentration Data File. The series proceeds in this manner to the end of the file unless terminated by the user.

The user selects the initial receptor site and date according to prompts and replies identical to those under the SELECT command. Then the user chooses the analytical method according to prompts and replies identical to those under the CMB command. There are no further prompts for the rest of the AUTOFIT series except the following (see PDATA command):

```
PRESS RETURN TO CONTINUE OR ENTER C FOR NEXT COMMAND
```

This prompt follows the displayed CMB coefficients. If the user enters a null line by pressing RETURN, the program displays the calculated concentrations in addition.

Unlike SELECT, entering a "C" under the AUTOFIT command will not bring up the prompt "ENTER COMMAND." Instead, the program proceeds to the next analysis, which it also does after displaying the calculated concentrations. The AUTOFIT sequence can be terminated at this point by keying in "STOP." The program then prompts "ENTER COMMAND."

If the user determines that he has mistakenly terminated the AUTOFIT series, it is not necessary to start over. The command RESUME may be entered immediately after the stop response to continue the AUTOFIT series.

3.3.16 RESUME

The RESUME command should only be used in conjunction with the AUTOFIT command. If the AUTOFIT sequence has been mistakenly terminated by a STOP response, the RESUME command will continue the autofit sequence.

3.3.17 BACKOUT

The BACKOUT command allows the user to remove the effect of background concentration from receptor concentration data. Subsequent CMB analyses reflect the background adjustment. The BACKIN command reverses the BACKOUT effects.

The BACKOUT command acts on the site/date receptor of the latest SELECT (or AUTOFIT) command. The queries and replies for the BACKOUT command are similar to those of the SELECT command:

```
ENTER BACKGROUND CMB SITE CODE:  XXXXXXXXXXXX
```

The user should enter the CMB site code for the site chosen to represent background concentration. Subsequent queries identical with those of the SELECT command ask for year and date. The user is not queried for size fraction since both sizes are adjusted.

3.3.18 BACKIN

The BACKIN command removes the background adjustment to receptor concentrations applied by BACKOUT. The user should be aware that some roundoff error may occur so that the BACKIN reversal of BACKOUT may not be perfect.

3.3.19 PCOMP

The PCOMP command computes and prints the average contributions of each source from a series of CMB analyses. The PCOMP command should follow an AUTOFIT command or a series of SELECT-WRITE commands emulating on AUTOFIT series.

A typical set of receptor concentration data could include a series of sampling dates at one receptor station or a group of receptors in a target area. The user would naturally want to compute the "average" CMB results in these cases. This is the purpose of PCOMP.

For PCOMP to work properly it must be preceded by a series of SELECT and WRITE commands for both fine and coarse fractions of each desired receptor concentration data set. The AUTOFIT does this automatically. Careful use of the SELECT and WRITE commands achieve the same end. However, whenever possible, the AUTOFIT command should be used to avoid errors.

The PCOMP command computes the average contribution from all complete CMB analyses following the previous PCOMP command or the initialization phase, whichever is later. The complete CMB analyses are those that included both fine and coarse analyses each followed by the WRITE command.

The output includes the labeled CMB coefficients from the averaged analyses, the averages according to sources, and the standard deviations. For each source, the mean and standard deviation are computed directly from the solutions for the different cases. A "solution" here is the calculated contribution to the ambient aerosol of a particular source. The means and standard deviations are not adjusted to account for the correlated error effect discussed in Section 2.

The PCOMP command gives one prompt to the user:

```
OUTPUT WILL GO TO HARDCOPY
DO YOU WANT IT DISPLAYED AT YOUR TERMINAL INSTEAD?
```

The user response "NO" will result in the output being written on the hardcopy. A "YES" brings the display to the user's terminal.

3.3.20 EXIT

The EXIT command terminates the interactive session. The user is returned to the time sharing system.

3.4 Detailed Formats of Data Files

The various input data files must be coded according to the specific formats presented here. The formats are presented as card images. However, the data should be on files accessible in interactive mode. For the receptor concentrations the data must be on a unit that responds to a FORTRAN REWIND. The other input data files are read only once.

Each data file line format is presented. Except for the receptor concentration data file, each data file includes only one card type. Since the CMB program is written in FORTRAN, the FORTRAN format of each item is given for the convenience of the user in determining acceptable entries.

In the following, the FORTRAN formats A, I, and F are referred to. The A format is used to read alphanumeric information. The integer following the A, e.g., the 8 in A8, gives the width of the field. The I format is used to read integers. For example, if the format is I4, the integer must be right-justified in a 4-character-wide field. Decimal points are not used with I format. The F format is used to read "floating-point," or arbitrary real numbers. The format F8.6 indicates that the field is 8 characters wide, and the rightmost 6 characters occur after the decimal point. For example, the number 12345678 would be read as 12.345678. More commonly, however, the decimal point is supplied. In this case the number can appear anywhere in the field.

All of the following numbers would be read as 12.3 if format F8.6 was used:

12.3____
__12.3__
____12.3

where the underscores indicate blanks.

Source Names and Codes

Column	Format	Contents
1-2	I2	Source code.
3-4	-	Skipped.
5-12	A8	Source Name.
13-80	-	Skipped. May contain user comment.

Species Names and Codes

Column	Format	Contents
1-2	I2	Species Code.
3-4	-	Skipped.
5-12	A8	Species Name.
13-80	-	Skipped. May contain user comment.

The fine and coarse fraction source signature matrices use the same line format.

Source Signature Matrix

Column	Format	Contents
1-2	I2	Source Code.
3-4	-	Skipped.
5-6	I2	Species Code.
7-8	-	Skipped.
9-16	F8.6	Fraction of Source for Species.
17-18	-	Skipped
19-26	F8.6	Standard Error of Fraction.
27-80	-	Skipped. May contain user comment.

A species code of '01' should not be used. Species code one is reserved for total aerosol. The program automatically generates the source signature vector for total aerosol.

The Receptor Concentration Data Set includes two card types. The card type '03' identifies the receptor. There is only one card type '03' per sampling date for each receptor location. The card type '30' gives the actual concentration data. There is a card type '30' for each species. The card type '30' lines follow directly after the corresponding card type '03.'

The concentration data may consist of fine and coarse fractions or of the fine fraction and total. This data type is indicated on the card type '03.'

Species code '01' is reserved for total aerosol. The total aerosol data are used in selecting the "best" ridge regression solution.

Receptor Concentration Data--Card Type 03 (Identification)

Column	Format	Contents
1-2	I2	'03'--card type.
3	-	Skipped.
4-15	3A4	Receptor identification.
16	-	Skipped.
17-18	A2	Year.
19-22	A4	Month and Day (MMDD).
23	-	Skipped.
24-25	I2	Duration of Sample (hours).
26	-	Skipped.
27-28	I2	Start hour of Sample.
29-32	-	Skipped.
33-34	I2	Data Type. '12'--Fine and Coarse '13'--Fine and Total
35-80	-	Must be blank.

Receptor Concentration Data--Card Type 30

Column	Format	Contents
1-2	I2	'30'--card type.
3	-	Skipped.
4-15	3A4	Receptor identification.
16	-	Skipped.
17-18	A2	Year.
19-22	A4	Month and Day (MMDD).
23	-	Skipped.
24-25	I2	Duration of Sample (hours).
26	-	Skipped.
27-28	I2	Start hour of Sample.
29-32	-	Skipped.
33-34	I2	Species Code.
35-36	-	Skipped.
37-45	F9.4	Fine Fraction Concentration.
46-47	-	Skipped.
48-56	F9.4	Standard Error of Fine Fraction.
57-58	-	Skipped.
59-67	F9.4	Coarse Fraction/Total Concentration.
68-69	-	Skipped.
70-78	F9.4	Standard Error of Coarse Fraction/Total.
79-80	-	Skipped.

The user followup data file is produced by the program and is not coded by the user. The format of the user followup data file is documented here for those who wish to make use of it.

The user followup data file includes three card types. Card types '03' and '30' are the same as Receptor Concentration Data Set card types '03' and '30'. Card type '40' gives the species concentration contributed by each source.

Recall that species 01 is the aerosol mass concentration for the size fraction being considered. The card type '40' entries for species 01 give the total aerosol contributions for their size fraction for the different sources.

Card types '03' and '30' are written whenever a receptor site and date are selected by the SELECT or AUTOFIT commands. Card type '40' is written by the WRITE command when both fine and coarse size fractions have been analyzed in succession.

User Followup Data--Card Type 40

Column	Format	Contents
1-2	I2	'40'--card type.
3	-	Skipped.
4-15	3A4	Receptor identification.
16	-	Skipped.
17-18	A2	Year.
19-22	A4	Month and Day (MMDD).
23	-	Skipped.
24-25	I2	Duration of Sample (hours).
26	-	Skipped.
27-28	I2	Start hour of Sample.
29	-	Skipped.
30-31	I2	Source Code.
32	-	Skipped.

User Followup Data--Card Type 40 (continued)

Column	Format	Contents
33-34	I2	Species Code.
35-36	-	Skipped.
37-45	F9.4	Fine Fraction Contribution (μg/m^3)
46-47	-	Skipped.
48-56	F9.4	Uncertainty of Fine Fraction.
57-58	-	Skipped.
59-67	F9.4	Coarse Fraction Contribution.
68-69	-	Skipped.
70-78	F9.4	Uncertainty of Coarse Fraction.
79-80	-	Skipped.

3.5 Command Reference Summary

This section gives a short description of the purpose and results of each command. This summary is intended to serve as a quick and ready reference for the user. Commands must be spelled out in full. However, a response to a query may be abbreviated by the first letter unless a numerical value or alphanumeric code is requested. Command details are given in Section 3.2.

HELP--This command lists all the commands with a brief statement of the purpose of each one.

SELECT--This command is used to select the receptor data set for the current CMB analysis. SELECT also automatically invokes CMB and PDATA. The user is prompted for the site, year, date and size fraction.

CMB--This command is used to determine the specific method options and to perform the CMB analysis. CMB also automatically invokes PDATA. Method options with CMB are ridge regression/least squares, effective variance method/no effective variances, and fitted model intercept/zero intercept. These options may be exercised in any combination.

PDATA--This command displays the current analysis solution at the user's terminal. The output consists of the solution coefficients and standard errors. The least squares coefficients, standard errors, and variance inflation factors are also displayed. Optionally, the receptor data and predicted values may be displayed for all species.

WRITE--This command writes results to hardcopy files. The WRITE command should follow the SELECT or CMB commands.

AE--This command is used to add species to the current fitting set. The program prompts the user for species to add.

DE--This command is used to delete species from the current fitting set. The program prompts the user for species to delete.

AS--This command is used to add sources to the current fitting set. The program prompts the user for sources to add.

DS--This command is used to delete sources from the current fitting set. The program prompts the user for sources to delete.

AUTOFIT--This command is used to perform automatically CMB analyses on a series of sites or dates (for both fine and coarse fractions). The AUTOFIT command saves time and prevents errors by eliminating repetitive entries. The AUTOFIT command is equivalent to a series of SELECT (CMB, PDATA) and WRITE commands.

RESUME--This command is used in conjunction with AUTOFIT to resume the autofit sequence.

BACKOUT--This command is used to remove the effect of background concentrations from receptor data. This command should be invoked after SELECT. The program prompts the user for site, year and date.

BACKIN--This command is used to cancel the effect of the BACKOUT command.

PMATRIX--This command is used to display the source signature matrix, the receptor data, species code list, and source code list. The program prompts the user for the items to display. Optionally, the output may go to the user's terminal or to hardcopy.

PSOLN--This command is used to display all ridge solutions, not merely the "best" one. Optionally, the output may go to the user's terminal or to hardcopy.

PINFO--This command displays the current problem status giving site, date, size, and background information. It is primarily useful to users of CRT terminals.

PCOMP--This command is used to compute and print the averages and standard deviations of a series of CMB analyses. Optionally, the output may go to the user's terminal or to hardcopy.

EXIT--This command terminates the CMB program processing.

3.6. Computer System Considerations

Certain tasks relevant to using the CMB program are contingent on the conventions of the particular computer being used. These include compilation and subprogram linkage, file access, and program execution. This section gives information pertinent to computer dependency. The emphasis of this information is oriented towards the EXEC 8 system of the Univac 1100 series, which was used in the program development. The requirements of IBM TSO are given a shorter discussion. The command names and syntax vary, but the tasks that must be performed are similar regardless of computer systems.

The physical characteristics of the eleven files accessed by the CMB program are as follows:

FORTRAN Unit #	Input/Output	Record or Line Length
2	Input	80
3	Input	80
5	Input	72 (Terminal)
6	Output	72 to 132 (Terminal)
7	Input	80
8	Input	80
9	Output	121 (Print File)
10	Input/Output	80 (Scratch Data File)
11	Output	133 (Print File)
12	Output	80
13	Input	80

The CMB program consists of a main program and five subprograms. All programs are written in FORTRAN. These programs are the following:

Program	Purpose
MAIN	Initialization and command sequence
FETCH	Read receptor concentration data
CMBR	Perform CMB analysis
PERC	Compute percentages and variances
COARS	Compute coarse fraction and variances
INV1	Matrix inversion

The program MAIN calls FETCH, CMBR, and PERC. FETCH calls COARS; CMBR calls INV1.

3.6.1 Univac System Conventions

This section describes one approach to using the CMB program on a Univac 1100 series computer. Other approaches are feasible. If the directions given here are followed, the CMB program can be invoked by a statement like the following:

```
@ADD CMB-RADPRG.HCS-FILE
```

Similarly, the hardcopy files may be printed by a statement like the following:

```
@ADD CMB-RADPRG.HCS-PRT
```

The following steps prepare the source code for execution. These steps need be performed only once if the result is saved.

```
@FTN,U CMB-RADPRG.MAIN,CMB-RADPRG.MAIN
@FTN,U CMB-RADPRG.FETCH,CMB-RADPRG.FETCH
@FTN,U CMB-RADPRG.CMBR,CMB-RADPRG.CMBR
@FTN,U CMB-RADPRG.PERC,CMB-RADPRG.PERC
@FTN,U CMB-RADPRG.COARS,CMB-RADPRG.COARS
@FTN,U CMB-RADPRG.INV1,CMB-RADPRG.INV1
@MAP,I CMB-RADPRG.MAP,CMB-RADPRG.CMB
IN CMB-RADPRG.MAIN,.CMBR,.COARS,.FETCH,.PERC,.INV1
END
```

The input data files must contain the data for the analyses. If the data are punched on cards, the cards may be loaded to the files using the @ELT command, as in the following example:

```
@ELT CMB-RADPRG.HCS-SORF
 --DATA CARDS FOR FINE SOURCE SIGNATURE--
@ELT CMB-RADPRG.HCS-SORC
 --DATA CARDS FOR COARSE SOURCE SIGNATURE--
@ELT CMB-RADPRG.HCS-DATA
 --DATA CARDS FOR RECEPTOR CONCENTRATION DATA--
@ELT CMB-RADPRG.HCS-PONM
 --DATA CARDS FOR SPECIES NAMES & CODES--
@ELT CMB-RADPRG.HCS-SONM
 --DATA CARDS FOR SOURCE NAMES & CODES--
```

Alternatively, the data may be entered directly onto the file in an interactive session using the editor:

```
@ED,I CMB-RADPRG.HCS-SORF
 --DATA LINES FOR FINE SOURCE SIGNATURE--
    ETC.
```

The following command sequence will define the files and begin execution of the CMB program. For convenience, these commands are best placed on a file element (using the editor) and brought into the runstream with an @ADD command. The approach given here assigns temporary SDF files, copies the permanent data onto the temporary files, sets up the FORTRAN unit numbers, and executes the CMB program.

```
@ASG,A CMB-RADPRG.
@FREE CMB-RADPRG.
@ASG,T TEMP.
@ASG,T MAGSTO.
@ASG,T SUMMRY.
@ASG,T CMBOUT.
@ASG,T HCS-PONM.
@ASG,T HCS-SORC.
@ASG,T HCS-SORF.
@ASG,T HCS-DATA.
@ASG,T HCS-SONM.
@COPY,I CMB-RADPRG.HCS-PONM,HCS-PONM.
@COPY,I CMB-RADPRG.HCS-SORC.HCS-SORC.
@COPY,I CMB-RADPRG.HCS-SORF,HCS-SORF.
@COPY,I CMB-RADPRG.HCS-DATA,HCS-DATA.
@COPY,I CMB-RADPRG.HCS-SONM,HCS-SONM.
@USE 2.,HCS-SONM.
@USE 3.,HCS-PONM.
@USE 7.,HCS-SORF.
```

```
@USE 8.,HCS-SORC.
@USE 9.,SUMMRY.
@USE 10.,TEMP.
@USE 11.,CMBOUT.
@USE 12.,MAGSTO.
@USE 13.,HCS-DATA.
@XQT CMB-RADPRG.CMB
```

These lines would be the contents of the file CMB-RADPRG.HCS-FILE used in the @ADD statement given at the beginning of this subsection.

These control statements or the equivalent @ADD statement begin the execution of the CMB program. The program proceeds as described in Sections 3.2 and 3.3. After the user has issued the EXIT command to the CMB program, control is returned to the system.

If the user's terminal is a printer terminal with 132 character print line width, then it can be used to print the hardcopy files and the user followup data file:

```
@HDG,P *** CMB MODEL : OUTPUT 'SUMMRY' DATA FILE ***
@ED,R SUMMRY.
P!
EXIT
@HDG,P *** CMB MODEL : OUTPUT 'CMBOUT' DATA FILE ***
@ED,R CMBOUT.
P!
EXIT
@HDG,P *** CMB MODEL : OUTPUT 'USER FOLLOWUP' DATA FILE ***
@ED,R MAGSTO.
P!
EXIT
```

These lines would be the content of the file CMB-RADPRG.HCS-FILE used in the @ADD statement given at the beginning of this subsection.

Alternatively, the results may be saved permanently for later printing on the system printer:

```
@COPY,I CMBOUT.,CMB-RADPRG.CMBOUT
@COPY,I SUMMRY.,CMB-RADPRG.SUMMRY
@COPY,I MAGSTO.,CMB-RADPRG.MAGSTO
```

3.6.2 IBM TSO System Considerations

The CMB program was developed on a Univac 1100 series computer. Nevertheless, every conscious effort was made to render the code compatible with IBM FORTRAN.

This section will briefly discuss the IBM TSO conventions needed to execute the CMB program.

The CMB programs can be compiled using the TSO FORT command or one of the FORTRAN batch compilers. The programs can be linked into a load module using the TSO LINK command or the batch linkage editor.

The input data files may be loaded from cards using the IBM utility IEBGENER. Alternatively, the lines may be entered directly using the TSO EDIT command.

The data files may be assigned FORTRAN unit numbers using the TSO ALLOCATE command, as in the following example:

```
ALLOC DA(CMB.HCS.PONM.DATA)   F(FT03F001)
```

The program can be executed using the TSO CALL command, as in the following example:

```
CALL   CMB.PDS.LOAD(CMB)
```

The ALLOCATE commands and the CALL command can be organized into a CLIST so that a single EXEC command will begin the CMB program execution.

The hardcopy prints may be displayed at the user's terminal using the TSO EDIT LIST command or sent to the system printer using the IBM utility PRTPCH.

SECTION 4

EXAMPLE RUN

4.1 Introduction

This section presents an example interactive session using the CMB program. This run of the CMB program exercises all of the commands. The purpose of this run is to illustrate the use of each command, and, as a result, it does not necessarily follow the course that an actual analysis might take. Moreover, the course of an actual analysis can vary significantly, depending on the nature and size of the ambient receptor data set and the objectives to be achieved by the analyses.

The example runs were executed on EPA's Univac 1100 series computer. The program was invoked with the command

```
@ADD CMB-RADPRG.HCS-FILE
```

as described in Section 3.6. The user's entries are preceded in the session by the symbol ">".

4.2 Illustration of Commands

```
WOULD YOU LIKE TO LOOK AT THE SOURCE AND SPECIES LISTS?
 TYPE YES OR NO.
```

The user replies "YES" so that he will get a list of the source and species numbers to refer to in the rest of the interactive session.

```
>YES
SOURCE SIGNATURE MATRICES ARE CODED AS FOLLOWS
SOURCES:
SOURCE #      SOURCE NAME

   1            SOIL
   2            RD DUST
   3            SEA SALT
   4            SLSH BRN
   5            AUTO CAT
   6            AUTO
   7            JET AIR
   8            RES OIL
   9            DIST OIL
  10            RES GAS
  11            COAL
  12            KRAFT RB
  13            ELARCFRN
  14            FERRMNFR
  15            CAL GYP
  16            CEMENT
  17            PET FCC
  18            LSKILN
  19            SEC SO4

SPECIES:
SPECIES #    SPECIES NAME
   1            TOTAL
   2            AL
   3            AS
   4            BA
   5            BR
   6            CA
   7            CD
   8            CL
   9            CO
  10            CR
  11            CU
  12            FE
  13            HG
  14            K
  15            MN
  16            NI
  17            P
  18            PB
  19            SO4
  20            SB
  21            SI
  22            SN
  23            SR
  24            TI
```

```
25          V
26          ZN
27          C
28          NA
29          NO3
30          RB
31          SE
```

Next, the user selects the sources using the source numbers in the above list. The user keys a "RETURN" or null line for "INITIAL SOURCE 15" to indicate that he has entered all of the desired sources. The program displays a list of the selected sources with their source numbers for the user's verification.

```
PLEASE INPUT INITIAL FITTING INFORMATION
INITIAL SOURCE  1: XX
>1
INITIAL SOURCE  2: XX
>2
INITIAL SOURCE  3: XX
>3
INITIAL SOURCE  4: XX
>5
INITIAL SOURCE  5: XX
>6
INITIAL SOURCE  6: XX
>7
INITIAL SOURCE  7: XX
>9
INITIAL SOURCE  8: XX
>10
INITIAL SOURCE  9: XX
>11
INITIAL SOURCE 10: XX
>12
INITIAL SOURCE 11: XX
>13
INITIAL SOURCE 12: XX
>14
```

```
INITIAL SOURCE 13: XX
>16
INITIAL SOURCE 14: XX
>17
INITIAL SOURCE 15: XX
>
INITIAL SOURCES
     1    SOIL
     2    RD DUST
     3    SEA SALT
     5    AUTO CAT
     6    AUTO
     7    JET AIR
     9    DIST OIL
    10    RES GAS
    11    COAL
    12    KRAFT RB
    13    ELARCFRN
    14    FERRMNFR
    16    CEMENT
    17    PET FCC
```

Next the user selects the species. This can be done individually as above with the sources. However, the user wants to enter "all" of the species. He keys a "-1" for "INITIAL SPECIES 1" and the first 21 (maximum allowable) species are selected. The program displays a list of them for the user's verification.

```
PLEASE INPUT SPECIES
INITIAL SPECIES  1: XX
>-1
INITIAL SPECIES
     1    TOTAL
     2    AL
     3    AS
     4    BA
     5    BR
     6    CA
     7    CD
     8    CL
     9    CO
```

```
10   CR
11   CU
12   FE
13   HG
14   K
15   MN
16   NI
17   P
18   PB
19   SO4
20   SB
21   SI
```

Next the program asks the user if the selected sources and species are correct. The user is satisfied with his choices (for the time being) and replies "YES." Then the program notes that the current size fraction is fine (rather than coarse). The session now enters the command phase.

```
ARE INITIAL SOURCES AND SPECIES CORRECT?
>YES
THE "HELP" COMMAND LISTS COMMANDS
SIZE IS  FINE
ENTER COMMAND
```

The user decides to give the HELP command to get a list of the commands and their uses.

```
>HELP
HELP-LISTS THESE COMMANDS

---- DATA ACCESS AND SEQUENCING ----
AUTOFIT-SEQUENCES AUTOMATICALLY TO NEXT DATA SET
RESUME-RESUME AUTOFIT
SELECT-SELECT DATA SET FOR CMB
SIZE-CHANGE SIZE FRACTION
EXIT-CLOSE FILES AND LEAVE
```

```
---- CMB OPERATIONS ----
AE-ADD A SPECIES TO THE FIT
DE-DELETE A SPECIES FROM THE FIT
AS-ADD A SOURCE TO THE FIT
DS-DELETE A SOURCE FROM THE FIT
CMB-PERFORM CMB:   OPTIONS ARE RIDGE & EFFECTIVE VARIANCE


---- SCREEN DISPLAY ----
PINFO-PRINT CURRENT STATUS ON SCREEN
PDATA-PRINT CURRENT CMB RESULTS ON SCREEN
PMATRIX-PRINT SOURCE SIGNATURE, RECEPTOR CONCENTRATIONS,
 OR SOURCE AND SPECIES CODE LISTS
PSOLN-PRINT ALL RIDGE SOLUTIONS
PCOMP-PRINT COMPUTED AVERAGES OF CMB SERIES

---- DATA STORAGE ----
WRITE-WRITE PRESENT CMB RESULTS TO FULL PRINTOUT,
        SUMMARY,AND USER FOLLOWUP STORAGE FILES

---- BACKGROUND SITE OPERATIONS ----
BACKOUT-SELECT AND SUBTRACT A BACKGROUND DATA SET
BACKIN-ELIMINATE CURRENT BACKGROUND SUBTRACTION


SELECT SHOULD NORMALLY BE THE FIRST COMMAND
ENTER COMMAND
```

The SELECT command will bring in receptor concentration data.

```
>SELECT
ENTER DESIRED CMB SITE CODE: XXXXXXXXXXXX
```

If the user does not know how the receptor sites are coded, he can reply with a question mark or any other incorrect response. Then the program will list the sites for him:

```
>?
ENTER YEAR: YY
>
ENTER DATE: MMDD
>
INPUT DESIRED SIZE FRACTION:(FINE OR COARSE)
```

```
>
DATA SEARCH BEGUN FOR
     SITE: ?               YEAR:     DATE:

     SITE: URBAN CORE      YEAR: 81  DATE: 0229     FC
     SITE: BACKGROUND      YEAR: 81  DATE: 0229     FC
DATA SET NOT FOUND FOR
     SITE: ?               YEAR:     DATE:
USE ONE OF THOSE LISTED ABOVE
ENTER COMMAND
```

Now the user knows what receptor site data are available. He gives the SELECT command again, choosing the Urban Core site. The sites and dates available depend on the data in the Receptor Concentration Data File described in Section 3. The data available for this interactive session are given in Appendix C.

```
>SELECT
ENTER DESIRED CMB SITE CODE: XXXXXXXXXXX
>URBAN CORE
ENTER YEAR: YY
>81
ENTER DATE: MMDD
>0229
INPUT DESIRED SIZE FRACTION:(FINE OR COARSE)
>FINE
DATA SEARCH BEGUN FOR
     SITE: URBAN CORE      YEAR: 81  DATE: 0229

     SITE: URBAN CORE      YEAR: 81  DATE: 0229     FC
```

The program now automatically moves into the CMB command.

```
DO YOU WANT RIDGE SOLUTIONS?
>YES
CMB WILL SELECT THE BEST RIDGE SOLUTION
DO YOU WANT TO SEE A SUMMARY OF THE OTHERS?
>NO
IN THE SELECTION OF THE BEST RIDGE SOLUTION,
WHAT WEIGHT DO YOU WANT?  (DEFAULT=1.0)
>
WEIGHT IS         1.000000000
DO YOU WANT TO USE EFFECTIVE VARIANCES?
>NO
DO YOU WANT TO INCLUDE THE INTERCEPT IN THE MODEL?
>YES
```

The user selects the method options by replying appropriately to the questions asked. The summary of the ridge solutions is illustrated later in this session. The default weight is selected by keying a RETURN or null line. Keying in "1.0" would have the same effect. Note that if a weight is given, the decimal point must be included.

The program now automatically enters the command PDATA.

```
CMB SITE: URBAN CORE       YEAR: 81   DATE: 0229      FRACTION:  FINE
SAMPLE DURATION: 12 WITH START HOUR:  7  BACKGROUND: NO   EFF VAR: NO
---------RIDGE REGRESSION--------    -----WEIGHTED LEAST SQUARES-----
  R-SQUARE: .8991   RIDGE K= .050             R-SQUARE: .9139
---SOURCE----------UG/M3---------    -------UG/M3----------VIF-------
  INTERCEPT       .004+-    .005           .004+-    .008
 1 SOIL           .448+-   1.089        -6.760+-  53.326 1383.677
 2 RD DUST        .011+-    .858          .878+-   6.047   86.913
 3 SEA SALT      -.313+-    .138         -.572+-    .869  128.630
 5 AUTO CAT      9.566+-   9.073        -6.683+-  80.143  113.999
 6 AUTO          4.013+-    .957         4.790+-   1.135    3.290
 7 JET AIR       3.520+-  44.126         3.542+-  58.707    1.941
 9 DIST OIL       .944+-   5.510         7.215+-  18.067   34.277
10 RES GAS        .295+-   2.361        12.645+-  86.973 1090.330
11 COAL          1.931+-   1.899         2.149+-  16.839  139.242
12 KRAFT RB      -.095+-   2.467          .912+-  24.370  219.996
13 ELARCFRN       .028+-    .190         -.033+-   3.765  553.312
14 FERRMNFR       .085+-    .145          .126+-   1.834  186.655
16 CEMENT        6.487+-   2.443         7.071+-  27.846  237.782
17 PET FCC       7.900+-   6.591         9.716+-  72.098  198.829
TOTAL:          34.824+-  48.266        35.000+-  50.671
MEASURED CONCENTRATION FINE/COARSE/TOTAL:
  35.00000+-   7.000/  75.00000+-   7.000/ 110.00000+-   9.899
```

This table presents the fitted coefficients and their standard errors for each source. Two sets of coefficients are given: the solution on the left is the "best" ridge solution (k = 0.050) and the solution on the right is the weighted least squares solution (k = 0.0).

The solutions consist of coefficient estimates with standard errors for each source. Variance inflation factors are given at the far right. At the bottom the calculated total aerosol is given for each solution. The measured total aerosol is also given for each size fraction.

Due to the complexity of the set of sources used and possibly also to uncertainties in the source signatures, both solutions contain large random errors for some sources. The large variance inflation factors for some sources indicate that strong multicollinearities exist. Notice, however, that the ridge solution has greatly reduced standard errors for the sources with large variance inflation factors. Also, the ridge solution has no significant negatives, although the weighted least squares solution has negatives with large magnitudes. This is typical in problems affected by multicollinearity.

```
PRESS RETURN TO CONTINUE OR ENTER C FOR NEXT COMMAND
```

The user can now proceed to a new command by entering a "C." However, the user wants to examine the calculated concentrations. He presses the return key to get this table:

```
--------------------------MEAS------------CALC----------RATIO----------
 1 TOTAL     *         35.000+- 7.000  34.824+-48.266    .99+- 1.39  TOT
 2 AL        *           .088+-  .062    .033+-  .004    .38+-  .27  AL
 3 AS        *           .036+-  .007    .004+-  .000    .12+-  .02  AS
 4 BA        *           .149+-  .014    .005+-  .000    .03+-  .00  BA
 5 BR        *           .344+-  .017    .334+-  .082    .97+-  .24  BR
 6 CA        *           .441+-  .023    .441+-  .082  1.00+-  .19  CA
 7 CD        *           .004+-  .002    .006+-  .000  1.55+-  .78  CD
 8 CL        *           .051+-  .007    .060+-  .069  1.17+- 1.37  CL
 9 CO        *           .003+-  .002    .004+-  .000  1.50+- 1.00  CO
10 CR        *                <  .004    .005+-  .000  2.58+- 5.16  CR
11 CU        *           .013+-  .002    .009+-  .001    .71+-  .12  CU
12 FE        *           .208+-  .011    .203+-  .029    .97+-  .15  FE
13 HG        *                <  .003    .004+-  .000    .00+-  .00  HG
14 K         *           .165+-  .009    .148+-  .033    .90+-  .20  K
15 MN        *           .022+-  .004    .023+-  .004  1.06+-  .26  MN
16 NI        *           .006+-  .001    .006+-  .000  1.04+-  .18  NI
17 P         *           .119+-  .017    .004+-  .000    .04+-  .01  P
18 PB        *          1.422+-  .068    .870+-  .212    .61+-  .15  PB
19 SO4       *         13.130+-  .681  13.027+- 1.832    .99+-  .15  SO4
20 SB        *           .003+-  .002    .005+-  .000  1.68+- 1.12  SB
21 SI        *           .277+-  .031    .305+-  .046  1.10+-  .21  SI
22 SN                           <  .002    .020+-  .004 20.40+-40.99  SN
23 SR                      .003+-  .001    .005+-  .000  1.54+-  .51  SR
24 TI                           <  .014    .008+-  .001  1.09+- 2.18  TI
25 V                            <  .008    .005+-  .000  2.29+- 9.15  V
26 ZN                      .042+-  .003    .046+-  .008  1.08+-  .21  ZN
27 C              M             <  .001  10.518+- 1.383    .00+-  .00  C
28 NA             M             <  .001   -.094+-  .024    .00+-  .00  NA
29 NO3            M             <  .001    .019+-  .003    .00+-  .00  NO3
30 RB             M             <  .001    .004+-  .000    .00+-  .00  RB
31 SE             M             <  .001    .004+-  .000    .00+-  .00  SE
ENTER COMMAND
```

For each species available the table above gives the measured concentration, the calculated concentration, and the ratio of the calculated to the measured concentration. Each quantity is accompanied by its standard error.

Those species that were included in the fitting process are marked with an asterisk (*). Those species that are marked with an "M" do not have receptor concentration data.

The user has the option to change the selection of sources and species and reperform the analysis. The effect of deleting undetected species Cr and Hg (10 and 13) and adding the detected but unused species Sr and Zn (23 and 26) could be investigated. In general, however, species which serve as key tracers for important sources should be included even if those species have small ambient concentrations. A tracer could be a species which constituted a small percentage of the aerosols from a given source but which was virtually unique to that source. Sources with negative coefficients are candidates for removal. Also, sources with standard errors many times larger than their coefficients are potential deletions. The indication is that the contribution of such sources is zero within random variability. The large SO_4 measured concentration indicates that sulfate sources are important. The secondary sulfate source (19) is a potential addition.

Upon examining his first trial the user determines that he wishes to change some of the fitting species and sources. He uses the DE command to delete species, the AE command to add species, the DS command to delete sources, and the AS command to add sources. In each case, the user terminates the command with a RETURN.

```
>DE
SIZE IS  FINE
INPUT CODE OF DELETED SPECIES
>10
INPUT CODE OF DELETED SPECIES
>13
INPUT CODE OF DELETED SPECIES
>
ENTER COMMAND
>AE
SIZE IS  FINE
INPUT CODE OF ADDED SPECIES
>23
INPUT CODE OF ADDED SPECIES
>26
```

```
INPUT CODE OF ADDED SPECIES
>
ENTER COMMAND
>DS
SIZE IS  FINE
INPUT CODE OF DELETED SOURCE
>12
INPUT CODE OF DELETED SOURCE
>7
INPUT CODE OF DELETED SOURCE
>
ENTER COMMAND
>AS
SIZE IS  FINE
INPUT CODE OF ADDED SOURCE
>19
INPUT CODE OF ADDED SOURCE
>
ENTER COMMAND
```

Now the user is ready to rerun the CMB analysis. It is not necessary to use SELECT again since the data have been already brought in for the desired site. Therefore, the user gives the CMB command.

```
>CMB
DO YOU WANT RIDGE SOLUTIONS?
>YES
CMB WILL SELECT THE BEST RIDGE SOLUTION
DO YOU WANT TO SEE A SUMMARY OF THE OTHERS?
>NO
IN THE SELECTION OF THE BEST RIDGE SOLUTION,
WHAT WEIGHT DO YOU WANT?  (DEFAULT=1.0)
>
WEIGHT IS          1.000000000
DO YOU WANT TO USE EFFECTIVE VARIANCES?
>NO
DO YOU WANT TO INCLUDE THE INTERCEPT IN THE MODEL?
>YES
```

```
CMB SITE: URBAN CORE       YEAR: 81   DATE: 0229      FRACTION:  FINE
SAMPLE DURATION: 12 WITH START HOUR:  7  BACKGROUND: NO   EFF VAR: NO
---------RIDGE REGRESSION--------    -----WEIGHTED LEAST SQUARES-----
  R-SQUARE: .9179   RIDGE K= .010           R-SQUARE: .9200
---SOURCE----------UG/M3---------    -------UG/M3----------VIF-------
  INTERCEPT       .004+-     .004        .005+-    .006
 1 SOIL          -.509+-    3.092      -8.858+-  27.313  432.869
 2 RD DUST       -.024+-     .923        .891+-   3.239   29.638
 3 SEA SALT      -.446+-     .171       -.533+-    .265   14.234
 5 AUTO CAT      7.377+-  20.436      -2.525+-  58.257   79.398
 6 AUTO          4.635+-     .941       4.800+-    .975    2.881
 9 DIST OIL      3.596+-    6.614       6.549+-  10.723   14.366
10 RES GAS       1.015+-    5.311      15.427+-  49.140  413.108
11 COAL          1.771+-    1.348       2.192+-   2.462    9.374
13 ELARCFRN       .076+-     .454        .048+-   1.249   71.640
14 FERRMNFR       .061+-     .250        .083+-    .612   24.698
16 CEMENT        7.403+-    2.919       7.999+-   4.322    6.798
17 PET FCC       8.221+-  12.252       9.410+-  41.216   77.121
19 SEC SO4       -.187+-  11.012      -3.353+-  49.346  173.618
TOTAL:          32.991+-  15.162      32.136+-  50.953
MEASURED CONCENTRATION FINE/COARSE/TOTAL:
  35.00000+-   7.000/  75.00000+-   7.000/ 110.00000+-   9.899


PRESS RETURN TO CONTINUE OR ENTER C FOR NEXT COMMAND
>C
ENTER COMMAND
```

This time the user gives a "C" and no receptor concentrations are displayed.

The user is now ready to look at the coarse fraction. The SIZE command switches the current size to coarse. Then the user adjusts his selection of sources. The species and sources for the coarse size fraction were not affected by the adjustments made for the fine fraction earlier.

```
>SIZE
SIZE IS COARSE
ENTER COMMAND
>DE
SIZE IS COARSE
INPUT CODE OF DELETED SPECIES
>3
INPUT CODE OF DELETED SPECIES
>7
INPUT CODE OF DELETED SPECIES
>13
INPUT CODE OF DELETED SPECIES
>16
INPUT CODE OF DELETED SPECIES
>19
INPUT CODE OF DELETED SPECIES
>20
INPUT CODE OF DELETED SPECIES
>
ENTER COMMAND
>AE
SIZE IS COARSE
INPUT CODE OF ADDED SPECIES
>23
INPUT CODE OF ADDED SPECIES
>24
INPUT CODE OF ADDED SPECIES
>26
INPUT CODE OF ADDED SPECIES
>
ENTER COMMAND
>DS
SIZE IS COARSE
INPUT CODE OF DELETED SOURCE
>7
INPUT CODE OF DELETED SOURCE
>9
INPUT CODE OF DELETED SOURCE
>10
INPUT CODE OF DELETED SOURCE
>13
INPUT CODE OF DELETED SOURCE
>14
INPUT CODE OF DELETED SOURCE
>17
INPUT CODE OF DELETED SOURCE
>
ENTER COMMAND
```

Now the user asks for a CMB analysis of the coarse fraction.

```
>CMB
DO YOU WANT RIDGE SOLUTIONS?
>SAME

CMB SITE: URBAN CORE       YEAR: 81   DATE: 0229      FRACTION: COARSE
SAMPLE DURATION: 12 WITH START HOUR:  7  BACKGROUND: NO   EFF VAR: NO
---------RIDGE REGRESSION--------    -----WEIGHTED LEAST SQUARES-----
  R-SQUARE: .6151   RIDGE K= .800           R-SQUARE: .7702
---SOURCE----------UG/M3---------    -------UG/M3----------VIF-------
  INTERCEPT       .011+-    .005          .023+-    .010
 1 SOIL         36.445+-  18.752        77.894+-  81.347    6.178
 2 RD DUST      13.578+-   6.185        18.281+-  13.310    2.184
 3 SEA SALT       .177+-    .491          .365+-    .771    1.223
 5 AUTO CAT     10.339+-  13.655       -51.096+-  63.596    6.754
 6 AUTO           .722+-    .275         1.180+-    .395    1.054
11 COAL          4.532+-   3.137        11.906+-   7.909    2.829
12 KRAFT RB      2.229+-   3.455         -.031+-   6.302    1.564
16 CEMENT       13.874+-  11.324        23.364+-  20.317    1.550
TOTAL:          81.908+-  25.267        81.884+-  43.046
MEASURED CONCENTRATION FINE/COARSE/TOTAL:
  35.00000+-   7.000/  75.00000+-   7.000/ 110.00000+-   9.899
PRESS RETURN TO CONTINUE OR ENTER C FOR NEXT COMMAND
>C
ENTER COMMAND
```

Note that the user replied "SAME" to the question "DO YOU WANT RIDGE SOLUTIONS?" The user wishes to use the same analysis method as in the previous CMB command. Thus, the user has asked for ridge solutions, no ridge summary, a selection weight of 1.0, no effective variances, and an intercept included in the model. Using the SAME reply can eliminate repetitive replies if the user chooses to use a consistent analysis method.

The user issues a WRITE command to record the output on hardcopy. The hardcopy output from this session is given in Appendix C. The hardcopy output includes tables similar to the source coefficient table and the calculated concentration table. Note that the latter will be included on the hardcopy even though it was not printed at the user's terminal.

```
>WRITE
WRITTEN
ENTER COMMAND
```

The user now would like to see the same analysis of the coarse fraction but with "background" removed. He gives the BACKOUT command and selects a background concentration receptor.

```
>BACKOUT
ENTER BACKGROUND CMB SITE CODE: XXXXXXXXXXXX
>BACKGROUND
ENTER YEAR: YY
>81
ENTER DATE: MMDD
>0229
     SITE: URBAN CORE       YEAR: 81  DATE: 0229     FC
     SITE: BACKGROUND       YEAR: 81  DATE: 0229     FC
BACKOUT COMPLETE
ENTER COMMAND
```

Now the user gives the CMB command to perform the analysis with background removed.

```
>CMB
DO YOU WANT RIDGE SOLUTIONS?
>SAME
```

```
CMB SITE: URBAN CORE       YEAR: 81   DATE: 0229      FRACTION: COARSE
SAMPLE DURATION: 12 WITH START HOUR:  7  BACKGROUND: YES  EFF VAR: NO
----------RIDGE REGRESSION---------    -----WEIGHTED LEAST SQUARES-----
  R-SQUARE: .4954   RIDGE K= .800            R-SQUARE: .6667
---SOURCE-----------UG/M3----------    -------UG/M3-----------VIF-------
  INTERCEPT       .010+-     .004           .021+-     .008
 1 SOIL         21.685+-   13.296         56.462+-   63.335      6.733
 2 RD DUST       8.110+-    4.089          9.703+-    9.882      2.465
 3 SEA SALT       .192+-     .300           .428+-     .543      1.423
 5 AUTO CAT      6.265+-    9.969        -48.147+-   51.722      7.508
 6 AUTO           .256+-     .207           .350+-     .313      1.059
11 COAL          3.435+-    2.114          9.835+-    6.250      3.414
12 KRAFT RB      2.065+-    2.730          -.074+-    5.670      1.772
16 CEMENT        8.208+-    7.614         14.206+-   14.487      1.575
TOTAL:          50.225+-   21.945         42.783+-   37.577
MEASURED CONCENTRATION FINE/COARSE/TOTAL:
   7.00000+-   7.616/  38.00000+-   8.062/  45.00000+-  11.091
PRESS RETURN TO CONTINUE OR ENTER C FOR NEXT COMMAND
>C
ENTER COMMAND
```

Note that the user again uses the reply SAME to eliminate repetition in asking for the same analysis method as previously.

The BACKIN command removes the effect of the BACKOUT command. This may be desired if a reanalysis of the raw site data is desired or if the user would like to try another background site.

```
>BACKIN
BACKIN COMPLETE
ENTER COMMAND
```

The next command given by the user is AUTOFIT, so the BACKIN command was not actually necessary in this case. The AUTOFIT command will sequence through both size fractions of a selected receptor and all subsequent receptors on the Receptor Concentration Data File. It also writes the results to the hardcopy.

```
>AUTOFIT
ENTER DESIRED CMB SITE CODE: XXXXXXXXXXXX
>URBAN CORE
ENTER YEAR: YY
>81
ENTER DATE: MMDD
>0229
DATA SEARCH BEGUN FOR
     SITE: URBAN CORE        YEAR: 81  DATE: 0229

     SITE: URBAN CORE        YEAR: 81  DATE: 0229     FC
DO YOU WANT RIDGE SOLUTIONS?
>YES
CMB WILL SELECT THE BEST RIDGE SOLUTION
DO YOU WANT TO SEE A SUMMARY OF THE OTHERS?
>NO
IN THE SELECTION OF THE BEST RIDGE SOLUTION,
WHAT WEIGHT DO YOU WANT?  (DEFAULT=1.0)
>
WEIGHT IS          1.000000000
DO YOU WANT TO USE EFFECTIVE VARIANCES?
>NO
NO
DO YOU WANT TO INCLUDE THE INTERCEPT IN THE MODEL?
>YES

CMB SITE: URBAN CORE        YEAR: 81   DATE: 0229      FRACTION:  FINE
SAMPLE DURATION: 12 WITH START HOUR:  7  BACKGROUND: NO   EFF VAR: NO
---------RIDGE REGRESSION--------    -----WEIGHTED LEAST SQUARES-----
  R-SQUARE: .9179   RIDGE K= .010           R-SQUARE: .9200
---SOURCE----------UG/M3---------    -------UG/M3----------VIF-------
  INTERCEPT       .004+-    .004            .005+-    .006
 1 SOIL          -.509+-   3.092          -8.858+-  27.313  432.869
 2 RD DUST       -.024+-    .923            .891+-   3.239   29.638
 3 SEA SALT      -.446+-    .171           -.533+-    .265   14.234
 5 AUTO CAT      7.377+-  20.436          -2.525+-  58.257   79.398
 6 AUTO          4.635+-    .941           4.800+-    .975    2.881
 9 DIST OIL      3.596+-   6.614           6.549+-  10.723   14.366
10 RES GAS       1.015+-   5.311          15.427+-  49.140  413.108
11 COAL          1.771+-   1.348           2.192+-   2.462    9.374
13 ELARCFRN       .076+-    .454            .048+-   1.249   71.640
14 FERRMNFR       .061+-    .250            .083+-    .612   24.698
16 CEMENT        7.403+-   2.919           7.999+-   4.322    6.798
17 PET FCC       8.221+-  12.252           9.410+-  41.216   77.121
19 SEC SO4       -.187+-  11.012          -3.353+-  49.346  173.618
TOTAL:          32.991+-  15.162          32.136+-  50.953
MEASURED CONCENTRATION FINE/COARSE/TOTAL:
  35.00000+-   7.000/  75.00000+-   7.000/ 110.00000+-   9.899
```

The user has entered information selecting the first site. He has also chosen the analysis method. The method chosen will be used for the remaining sites and size fractions for the AUTOFIT sequence.

```
PRESS RETURN TO CONTINUE OR ENTER C FOR NEXT COMMAND
```

The program pauses for a reply to the above prompt. However, a "C" does not return the user to command mode. Instead the program follows the above CMB analysis of the fine fraction of URBAN CORE with the CMB analysis of the coarse fraction. Note also that hardcopy is "WRITTEN."

```
>C
WRITTEN

CMB SITE: URBAN CORE       YEAR: 81   DATE: 0229      FRACTION: COARSE
SAMPLE DURATION: 12 WITH START HOUR:  7  BACKGROUND: NO    EFF VAR: NO
---------RIDGE REGRESSION--------    -----WEIGHTED LEAST SQUARES-----
  R-SQUARE: .6151   RIDGE K= .800           R-SQUARE: .7702
---SOURCE----------UG/M3---------    -------UG/M3----------VIF-------
  INTERCEPT        .011+-    .005          .023+-     .010
 1 SOIL          36.445+-  18.752        77.894+-   81.347     6.178
 2 RD DUST       13.578+-   6.185        18.281+-   13.310     2.184
 3 SEA SALT        .177+-    .491          .365+-     .771     1.223
 5 AUTO CAT      10.339+-  13.655       -51.096+-   63.596     6.754
 6 AUTO            .722+-    .275         1.180+-     .395     1.054
11 COAL           4.532+-   3.137        11.906+-    7.909     2.829
12 KRAFT RB       2.229+-   3.455         -.031+-    6.302     1.564
16 CEMENT        13.874+-  11.324        23.364+-   20.317     1.550
TOTAL:           81.908+-  25.267        81.884+-   43.046
MEASURED CONCENTRATION FINE/COARSE/TOTAL:
  35.00000+-   7.000/  75.00000+-   7.000/ 110.00000+-   9.899
```

Note that the sources for the fine and coarse fractions are different. The sources (and species) used are the selections currently in effect for each size fraction. These were determined in the initialization phase and by AS, AE, DS, and DE commands.

The user decides to display the calculated concentrations for the coarse fraction of the URBAN CORE site.

```
PRESS RETURN TO CONTINUE OR ENTER C FOR NEXT COMMAND
>
--------------------------MEAS------------CALC----------RATIO----------
 1 TOTAL     *         75.000+- 7.000  81.908+-25.267  1.09+-  .35  TOT
 2 AL        *          1.951+-  .422   1.125+-  .229   .58+-  .17  AL
 3 AS                    .004+-  .004    .011+-  .000  2.76+- 2.76  AS
 4 BA        *           .371+-  .023    .011+-  .000   .03+-  .00  BA
 5 BR        *           .108+-  .007    .073+-  .015   .67+-  .14  BR
 6 CA        *         13.014+- 1.442   5.186+-  .842   .40+-  .08  CA
 7 CD                         <  .001    .011+-  .000 22.10+-44.19  CD
 8 CL        *           .288+-  .068    .212+-  .031   .74+-  .20  CL
 9 CO        *           .015+-  .003    .011+-  .000   .74+-  .15  CO
10 CR        *           .022+-  .005    .022+-  .003   .99+-  .26  CR
11 CU        *           .018+-  .002    .018+-  .001  1.01+-  .13  CU
12 FE        *          1.871+-  .118   1.204+-  .205   .64+-  .12  FE
13 HG                         <  .002    .011+-  .000 11.05+-22.10  HG
14 K         *           .517+-  .072    .347+-  .070   .67+-  .17  K
15 MN        *           .088+-  .008    .035+-  .004   .40+-  .06  MN
16 NI                    .003+-  .001    .018+-  .001  5.83+- 1.99  NI
17 P         *           .102+-  .040    .011+-  .000   .11+-  .04  P
18 PB        *           .346+-  .024    .171+-  .038   .49+-  .12  PB
19 SO4                  1.725+-  .939   6.525+- 1.306  3.78+- 2.19  SO4
20 SB                    .004+-  .002    .011+-  .000  2.76+- 1.38  SB
21 SI        *          8.652+- 1.987   6.335+- 1.048   .73+-  .21  SI
22 SN                    .005+-  .002    .011+-  .000  2.21+-  .88  SN
23 SR        *           .030+-  .003    .016+-  .001   .54+-  .07  SR
24 TI        *           .205+-  .037    .181+-  .035   .88+-  .23  TI
25 V                          <  .014    .015+-  .001  2.10+- 4.21  V
26 ZN        *           .071+-  .006    .054+-  .008   .76+-  .13  ZN
27 C             M            <  .001   8.129+- 1.224   .00+-  .00  C
28 NA            M            <  .001    .422+-  .068   .00+-  .00  NA
29 NO3           M            <  .001    .014+-  .001   .00+-  .00  NO3
30 RB            M            <  .001    .012+-  .000   .00+-  .00  RB
31 SE            M            <  .001    .011+-  .000   .00+-  .00  SE
>
WRITTEN
WRITTEN
```

Note that the program paused at the end of the table display. The user gave a RETURN to continue processing. The program replied with two "WRITTEN" messages, indicating that the coarse fraction results have been written to hardcopy and that a site summary report has been written. The User Followup Data File was also written upon at this point.

The program now proceeds to the next site. First it brings in the concentration data, then displays the analysis.

```
DATA SEARCH BEGUN FOR
     SITE: BACKGROUND       YEAR: 81  DATE: 0229

     SITE: URBAN CORE       YEAR: 81  DATE: 0229     FC
     SITE: BACKGROUND       YEAR: 81  DATE: 0229     FC

CMB SITE: BACKGROUND       YEAR: 81   DATE: 0229      FRACTION:  FINE
SAMPLE DURATION: 12 WITH START HOUR:  7  BACKGROUND: NO   EFF VAR: NO
---------RIDGE REGRESSION--------    -----WEIGHTED LEAST SQUARES-----
  R-SQUARE: .8287   RIDGE K= .120             R-SQUARE: .9241
---SOURCE----------UG/M3---------    -------UG/M3----------VIF-------
  INTERCEPT       .006+-     .006           .005+-    .006
 1 SOIL          -.334+-     .346        -14.654+-  34.854 7594.633
 2 RD DUST        .214+-     .656          1.231+-   3.814   91.330
 3 SEA SALT      -.187+-     .093          -.667+-    .264   19.554
 5 AUTO CAT    12.538+-    7.325        -26.438+-  39.874   52.511
 6 AUTO         1.889+-     .609          2.261+-    .522    1.823
 9 DIST OIL     1.572+-    3.786         20.923+-  12.055   25.512
10 RES GAS      -.735+-     .733         17.660+-  61.095 6725.402
11 COAL         1.088+-     .951          3.035+-   2.132   13.675
13 ELARCFRN     -.053+-     .114          -.117+-    .974   93.757
14 FERRMNFR      .147+-     .137           .186+-    .498   22.554
16 CEMENT       2.884+-    1.166          9.390+-   3.855   30.223
17 PET FCC      4.596+-    4.504          6.337+-  24.170   55.903
19 SEC SO4      4.025+-    4.481          7.995+-  30.701   78.138
TOTAL:         27.650+-    7.882         27.147+-  20.851
MEASURED CONCENTRATION FINE/COARSE/TOTAL:
  28.00000+-   3.000/  37.00000+-   4.000/  65.00000+-   5.000
```

The user decides to stop the AUTOFIT sequence and return to command mode.

```
PRESS RETURN TO CONTINUE OR ENTER C FOR NEXT COMMAND
>STOP
ENTER COMMAND
```

The user is now in command mode and may enter any valid command. However, he decides that he would like to continue the AUTOFIT sequence after all. He enters the RESUME command and the programs takes up the AUTOFIT sequence where it left off.

```
>RESUME
WRITTEN

CMB SITE: BACKGROUND       YEAR: 81   DATE: 0229      FRACTION: COARSE
SAMPLE DURATION: 12 WITH START HOUR:  7  BACKGROUND: NO   EFF VAR: NO
---------RIDGE REGRESSION--------    -----WEIGHTED LEAST SQUARES-----
  R-SQUARE: .8785   RIDGE K= .480             R-SQUARE: .9570
---SOURCE----------UG/M3---------    -------UG/M3----------VIF-------
  INTERCEPT       .003+-    .002           .003+-    .003
 1 SOIL         20.253+-   5.861         27.211+-  16.919     7.651
 2 RD DUST       6.130+-   1.363          7.989+-   2.435     3.687
 3 SEA SALT      -.024+-    .031          -.053+-    .114    10.065
 5 AUTO CAT      1.749+-   4.822         -9.926+-  14.544     8.157
 6 AUTO           .540+-    .106           .820+-    .099     1.130
11 COAL          1.397+-    .840          2.655+-   1.708     4.580
12 KRAFT RB       .053+-    .538          -.156+-   2.073    10.701
16 CEMENT        6.954+-   2.694          9.610+-   3.288     1.852
TOTAL:          37.055+-  13.502         38.153+-  21.236
MEASURED CONCENTRATION FINE/COARSE/TOTAL:
  28.00000+-   3.000/  37.00000+-   4.000/  65.00000+-   5.000
PRESS RETURN TO CONTINUE OR ENTER C FOR NEXT COMMAND
>C
WRITTEN
WRITTEN
AUTOFIT SEQUENCING FINISHED
ENTER COMMAND
```

The program has noted that the AUTOFIT sequence is finished.

The user would now like to average the previous analyses across sites (or dates if there were multiple dates). This is done with the PCOMP command. Only site analyses which were followed by the double "WRITTEN" message are included. Ordinarily, the results to be averaged are of a comparable nature, e.g., averages could be computed for a set of sites in the urban core for one or more dates. However, averaging the urban core and background sites illustrates the mechanics.

```
>PCOMP
OUTPUT WILL GO TO HARDCOPY.
DO YOU WANT IT DISPLAYED AT YOUR TERMINAL INSTEAD?
>YES

                                         FINE        COARSE        TOTAL
  CMB SITE       DATE     SOURCE        (UG/M3)      (UG/M3)      (UG/M3)
  --------       ----     ------        -------      -------      -------

URBAN CORE     81/02/29  SOIL             -.51        36.45        35.94
BACKGROUND     81/02/29  SOIL             -.33        20.25        19.92

                                        -------      -------      -------
                   AVERAGE                -.42        28.35        27.93
                 (STD. DEV.)     +-        .12   +-   11.45   +-   11.33

                                         FINE        COARSE        TOTAL
  CMB SITE       DATE     SOURCE        (UG/M3)      (UG/M3)      (UG/M3)
  --------       ----     ------        -------      -------      -------

URBAN CORE     81/02/29  RD DUST          -.02        13.58        13.55
BACKGROUND     81/02/29  RD DUST           .21         6.13         6.34

                                        -------      -------      -------
                   AVERAGE                 .10         9.85         9.95
                 (STD. DEV.)     +-        .17   +-    5.27   +-    5.10
```

CMB SITE	DATE	SOURCE		FINE (UG/M3)		COARSE (UG/M3)		TOTAL (UG/M3)
URBAN CORE	81/02/29	SEA SALT		-.45		.18		-.27
BACKGROUND	81/02/29	SEA SALT		-.19		-.02		-.21
	AVERAGE			-.32		.08		-.24
	(STD. DEV.)		+-	.18	+-	.14	+-	.04

CMB SITE	DATE	SOURCE		FINE (UG/M3)		COARSE (UG/M3)		TOTAL (UG/M3)
URBAN CORE	81/02/29	AUTO CAT		7.38		10.34		17.72
BACKGROUND	81/02/29	AUTO CAT		12.54		1.75		14.29
	AVERAGE			9.96		6.04		16.00
	(STD. DEV.)		+-	3.65	+-	6.07	+-	2.43

CMB SITE	DATE	SOURCE		FINE (UG/M3)		COARSE (UG/M3)		TOTAL (UG/M3)
URBAN CORE	81/02/29	AUTO		4.63		.72		5.36
BACKGROUND	81/02/29	AUTO		1.89		.54		2.43
	AVERAGE			3.26		.63		3.89
	(STD. DEV.)		+-	1.94	+-	.13	+-	2.07

CMB SITE	DATE	SOURCE		FINE (UG/M3)		COARSE (UG/M3)		TOTAL (UG/M3)
URBAN CORE	81/02/29	DIST OIL		3.60		.00		3.60
BACKGROUND	81/02/29	DIST OIL		1.57		.00		1.57
	AVERAGE			2.58		.00		2.58
	(STD. DEV.)		+-	1.43	+-	.00	+-	1.43

```
                                              FINE         COARSE         TOTAL
   CMB SITE        DATE     SOURCE          (UG/M3)       (UG/M3)       (UG/M3)
   --------        ----     ------          -------       -------       -------

 URBAN CORE      81/02/29   RES GAS           1.02            .00          1.02
 BACKGROUND      81/02/29   RES GAS           -.73            .00          -.73

                                            -------       -------       -------
                       AVERAGE                 .14            .00           .14
                     (STD. DEV.)      +-      1.24    +-      .00   +-     1.24

                                              FINE         COARSE         TOTAL
   CMB SITE        DATE     SOURCE          (UG/M3)       (UG/M3)       (UG/M3)
   --------        ----     ------          -------       -------       -------

 URBAN CORE      81/02/29   COAL              1.77           4.53          6.30
 BACKGROUND      81/02/29   COAL              1.09           1.40          2.49

                                            -------       -------       -------
                       AVERAGE                1.43           2.96          4.39
                     (STD. DEV.)      +-       .48    +-     2.22   +-     2.70

                                              FINE         COARSE         TOTAL
   CMB SITE        DATE     SOURCE          (UG/M3)       (UG/M3)       (UG/M3)
   --------        ----     ------          -------       -------       -------

 URBAN CORE      81/02/29   KRAFT RB           .00           2.23          2.23
 BACKGROUND      81/02/29   KRAFT RB           .00            .05           .05

                                            -------       -------       -------
                       AVERAGE                 .00           1.14          1.14
                     (STD. DEV.)      +-       .00    +-     1.54   +-     1.54

                                              FINE         COARSE         TOTAL
   CMB SITE        DATE     SOURCE          (UG/M3)       (UG/M3)       (UG/M3)
   --------        ----     ------          -------       -------       -------

 URBAN CORE      81/02/29   ELARCFRN           .08            .00           .08
 BACKGROUND      81/02/29   ELARCFRN          -.05            .00          -.05

                                            -------       -------       -------
                       AVERAGE                 .01            .00           .01
                     (STD. DEV.)      +-       .09    +-      .00   +-      .09
```

```
                                             FINE         COARSE        TOTAL
     CMB SITE        DATE     SOURCE       (UG/M3)       (UG/M3)       (UG/M3)
     --------        ----     ------       -------       -------       -------

    URBAN CORE     81/02/29  FERRMNFR        .06           .00           .06
    BACKGROUND     81/02/29  FERRMNFR        .15           .00           .15

                                           -------       -------       -------
                       AVERAGE               .10           .00           .10
                     (STD. DEV.)     +-      .06     +-    .00     +-    .06

                                             FINE         COARSE        TOTAL
     CMB SITE        DATE     SOURCE       (UG/M3)       (UG/M3)       (UG/M3)
     --------        ----     ------       -------       -------       -------

    URBAN CORE     81/02/29  CEMENT         7.40         13.87         21.28
    BACKGROUND     81/02/29  CEMENT         2.88          6.95          9.84

                                           -------       -------       -------
                       AVERAGE              5.14         10.41         15.56
                     (STD. DEV.)     +-     3.20     +-   4.89     +-   8.09

                                             FINE         COARSE        TOTAL
     CMB SITE        DATE     SOURCE       (UG/M3)       (UG/M3)       (UG/M3)
     --------        ----     ------       -------       -------       -------

    URBAN CORE     81/02/29  PET FCC        8.22           .00          8.22
    BACKGROUND     81/02/29  PET FCC        4.60           .00          4.60

                                           -------       -------       -------
                       AVERAGE              6.41           .00          6.41
                     (STD. DEV.)     +-     2.56     +-    .00     +-   2.56

                                             FINE         COARSE        TOTAL
     CMB SITE        DATE     SOURCE       (UG/M3)       (UG/M3)       (UG/M3)
     --------        ----     ------       -------       -------       -------

    URBAN CORE     81/02/29  SEC SO4        -.19           .00          -.19
    BACKGROUND     81/02/29  SEC SO4        4.02           .00          4.02

                                           -------       -------       -------
                       AVERAGE              1.92           .00          1.92
                     (STD. DEV.)     +-     2.98     +-    .00     +-   2.98

   ENTER COMMAND
```

The user would like to know what the current status is. That is, what are the current site, size fraction, sources, and species. He enters the PINFO command.

```
>PINFO
               ***CURRENT STATUS***
CMB SITE: BACKGROUND       YEAR: 81   DATE: 0229
COARSE  SIZE FRACTION
DURATION: 12  START HOUR:  7
HAS BACKGROUND BEEN SUBTRACTED: NO
FITTING SPECIES
     1   TOTAL
     2   AL
     4   BA
     5   BR
     6   CA
     8   CL
     9   CO
    10   CR
    11   CU
    12   FE
    14   K
    15   MN
    17   P
    18   PB
    21   SI
    23   SR
    24   TI
    26   ZN
FITTING SOURCES
     1   SOIL
     2   RD DUST
     3   SEA SALT
     5   AUTO CAT
     6   AUTO
    11   COAL
    12   KRAFT RB
    16   CEMENT
ENTER COMMAND
```

This shows that the last site and size fraction analyzed in the AUTOFIT sequence is current.

The user decides to do an alternate analysis. He chooses ridge regression as before, but he asks for the summary of all solutions. He also sets the weight to 10.0, favoring the selection of a solution without significant negative coefficients. Also, he chooses the effective variance option.

```
>CMB
DO YOU WANT RIDGE SOLUTIONS?
>Y
CMB WILL SELECT THE BEST RIDGE SOLUTION
DO YOU WANT TO SEE A SUMMARY OF THE OTHERS?
>Y
IN THE SELECTION OF THE BEST RIDGE SOLUTION,
WHAT WEIGHT DO YOU WANT?  (DEFAULT=1.0)
>10.
WEIGHT IS        10.000000000
DO YOU WANT TO USE EFFECTIVE VARIANCES?
>Y
DO YOU WANT TO INCLUDE THE INTERCEPT IN THE MODEL?
>Y
```

Note that the user does not spell out "YES" but instead merely gives a "Y." He could also use "N" for "NO." The first letter can be used for most replies to the CMB program queries. It cannot be used for COMMANDS.

The CMB program now displays the summary of solutions.

```
RIDGE K  R-SQUARE   AEROSOL   SE(AEROSOL)  # NEG    WORST  ITERATIONS
  .000     .8837    37.315      16.01       3     -6.547       3
  .005     .8836    37.293      15.91       3     -5.666       2
  .010     .8837    37.276      15.83       3     -4.919       2
  .015     .8838    37.263      15.75       3     -4.267       2
  .020     .8838    37.253      15.67       3     -3.692       2
  .025     .8839    37.244      15.60       3     -3.181       2
  .030     .8839    37.236      15.52       3     -2.723       2
  .035     .8839    37.229      15.45       3     -2.310       2
  .040     .8839    37.222      15.38       3     -1.936       2
  .045     .8838    37.215      15.31       3     -1.596       2
  .050     .8838    37.208      15.24       3     -1.284       2
  .060     .8837    37.192      15.11       3      -.735       2
  .070     .8835    37.175      14.99       3      -.274       2
  .080     .8832    37.154      14.87       2      -.271       2
  .090     .8829    37.131      14.75       2      -.267       2
  .100     .8826    37.104      14.64       2      -.262       2
  .120     .8817    37.042      14.42       2      -.252       2
  .140     .8806    36.969      14.22       2      -.240       2
  .160     .8793    36.885      14.03       2      -.228       2
  .180     .8778    36.792      13.85       2      -.216       2
  .200     .8762    36.691      13.68       2      -.204       2
  .240     .8725    36.469      13.37       2      -.181       2
  .280     .8682    36.226      13.08       2      -.159       2
  .320     .8635    35.966      12.82       2      -.139       2
  .360     .8584    35.693      12.58       2      -.120       2
  .400     .8530    35.412      12.35       2      -.103       2
  .480     .8414    34.832      11.93       2      -.072       2
  .560     .8291    34.241      11.56       2      -.046       2
  .640     .8164    33.649      11.22       2      -.023       2
  .720     .8033    33.062      10.90       2      -.013       2
  .800     .7900    32.483      10.61       1      -.012       2

RIDGE K=  .180 IS THE SELECTED BEST SOLUTION
```

The R^2 value is given for each value of the ridge K. The calculated total aerosol mass and its standard error are also given. The program tries to find a solution with this calculated value close to the measured value, which is 35 $\mu g/m^3$ in this case. The number of negative coefficients is also given along with the value of the negative coefficient of greatest magnitude. Finally, the number of iterations in the effective variance procedure is given.

In conventional ridge regression, the R^2 value is highest for the case when k = 0. Due to certain required data transformations discussed in Appendix D, however, R^2 may oscillate in some cases as k increases if effective variances are used. The R^2 value is a measure of the agreement between observed and predicted concentrations after the variance stabilizing transformation.

Next the CMB program displays the chosen best solution.

```
CMB SITE: BACKGROUND        YEAR: 81   DATE: 0229      FRACTION: COARSE
SAMPLE DURATION: 12 WITH START HOUR:  7  BACKGROUND: NO   EFF VAR: YES
---------RIDGE REGRESSION--------     -----WEIGHTED LEAST SQUARES-----
  R-SQUARE: .8778   RIDGE K= .180            R-SQUARE: .8837
---SOURCE----------UG/M3---------     -------UG/M3----------VIF-------
  INTERCEPT       .003+-    .002            .004+-    .003
 1 SOIL         15.349+-   6.147          22.079+-  19.624    9.394
 2 RD DUST       7.963+-   2.190           8.616+-   3.282    1.881
 3 SEA SALT      -.031+-    .047           -.054+-    .120    4.668
 5 AUTO CAT      2.453+-   4.943          -6.547+-  16.549    8.510
 6 AUTO           .687+-    .206            .847+-    .286    1.261
11 COAL          1.255+-    .925           2.268+-   2.178    2.815
12 KRAFT RB      -.216+-    .794           -.203+-   1.980    4.853
16 CEMENT        9.329+-   3.380          10.305+-   5.092    2.009
TOTAL:          36.792+-  13.852          37.315+-  16.005
MEASURED CONCENTRATION FINE/COARSE/TOTAL:
  28.00000+-   3.000/  37.00000+-   4.000/  65.00000+-   5.000
PRESS RETURN TO CONTINUE OR ENTER C FOR NEXT COMMAND
>C
ENTER COMMAND
```

The user would like to look at all of the solutions. He therefore enters the PSOLN command.

```
>PSOLN
THERE ARE 31 SOLUTIONS WITH AN INTERCEPT
AND  8 SOURCE COEFICIENTS AND STANDARD ERRORS
EACH FOR  527 NUMBERS TOTAL.
THEY CAN PRINT TO YOUR TERMINAL OR TO HARD COPY.
ARE YOU SURE YOU WANT TO LOOK AT THESE NUMBERS?
>Y
DO YOU WANT THE SOLUTIONS PRINTED ON THE HARD COPY
(INSTEAD OF AT YOUR TERMINAL)?
>Y
SOLUTIONS WRITTEN TO HARD COPY
ENTER COMMAND
```

Recognizing the volume of data in the display, the user has elected to send the results to the hardcopy. The results are included in Appendix C. Note that the user is continuing to use shorthand replies.

The user would like to check some of the input data. He enters the PMATRIX command.

```
>PMATRIX
MATRICES CAN GO TO HARD COPY
DO YOU WANT THEM DISPLAYED AT YOUR TERMINAL INSTEAD?
>Y
WHAT DO YOU WANT TO SEE?
SOURCE SIGNATURE, RECEPTOR CONCENTRATIONS, OR CODES?
>RECEPTORS
```

The user spelled out "RECEPTORS," but the abbreviation "R" could have been used. The display is as follows:

```
CURRENT MEASURED UG/M3 CONCENTRATIONS FOR
SITE:BACKGROUND       YEAR: 81  DATE: 0229
-----------------------------------------------------------------------
SPECIES               FINE              COARSE                TOTAL
-----------------------------------------------------------------------


 1 TOTAL      28.000+-   3.000   37.000+-   4.000   65.000+-   5.000
 2 AL           .070+-    .055     .739+-    .171     .809+-    .180
 3 AS           .014+-    .006     .001+-    .004     .015+-    .007
 4 BA           .146+-    .018     .086+-    .016     .232+-    .024
 5 BR           .164+-    .010     .064+-    .005     .228+-    .011
 6 CA           .128+-    .008    3.805+-    .444    3.933+-    .444
 7 CD           .001+-    .002     .001+-    .002     .002+-    .003
 8 CL           .010+-    .007     .014+-    .010     .024+-    .012
 9 CO           .008+-    .003     .001+-    .003     .009+-    .004
10 CR           .010+-    .005     .003+-    .005     .012+-    .007
11 CU           .027+-    .003     .004+-    .002     .031+-    .004
12 FE           .120+-    .008     .692+-    .044     .812+-    .045
13 MG           .001+-    .003     .009+-    .003     .010+-    .004
14 K            .186+-    .010     .215+-    .032     .401+-    .034
15 MN           .022+-    .004     .018+-    .004     .040+-    .006
16 NI           .003+-    .002     .001+-    .002     .004+-    .003
17 P            .103+-    .018     .020+-    .022     .123+-    .028
18 PB           .894+-    .047     .213+-    .017    1.107+-    .050
19 SO4        14.780+-    .765     .852+-    .783   15.632+-   1.095
20 SB           .008+-    .003     .001+-    .003     .009+-    .004
21 SI           .189+-    .027    4.000+-    .914    4.189+-    .914
22 SN           .024+-    .003     .003+-    .003     .027+-    .004
23 SR           .003+-    .002     .006+-    .002     .009+-    .003
24 TI           .008+-    .016     .097+-    .017     .105+-    .023
25 V            .003+-    .009     .003+-    .007     .006+-    .011
26 ZN           .038+-    .003     .016+-    .003     .054+-    .004
27 C            .000+-    .001     .000+-    .001     .000+-    .001
28 NA           .000+-    .001     .000+-    .001     .000+-    .001
29 NO3          .000+-    .001     .000+-    .001     .000+-    .001
30 RB           .000+-    .001     .000+-    .001     .000+-    .001
31 SE           .000+-    .001     .000+-    .001     .000+-    .001
```

The CMB program again asks the user what input data should be displayed. This time the user selects the source signature matrix. However, he only wishes to look at one of the sources, not the entire matrix:

```
WHAT DO YOU WANT TO SEE?
SOURCE SIGNATURE. RECEPTOR CONCENTRATIONS, OR CODES?
OR ARE YOU DONE?
>SOURCES
WHAT SIZE FRACTION? (FINE OR COARSE)
>C
DO YOU WANT TO LOOK AT THE WHOLE MATRIX?
IT IS 19 SOURCES BY 31 SPECIES
>N
WHICH SOURCE DO YOU WANT?
GIVE SOURCE #
>2
SOURCE: RD DUST
 1 TOTAL      1.0000  +-    .0000
 2 AL          .0659  +-    .0165
 3 AS          .0000  +-    .0000
 4 BA          .0000  +-    .0000
 5 BR          .0001  +-    .0000
 6 CA          .0300  +-    .0075
 7 CD          .0000  +-    .0000
 8 CL          .0000  +-    .0000
 9 CO          .0000  +-    .0000
10 CR          .0000  +-    .0000
11 CU          .0000  +-    .0000
12 FE          .0573  +-    .0143
13 HG          .0000  +-    .0000
14 K           .0000  +-    .0000
15 MN          .0010  +-    .0003
16 NI          .0000  +-    .0000
17 P           .0000  +-    .0000
18 PB          .0000  +-    .0000
19 SO4         .0000  +-    .0000
20 SB          .0000  +-    .0000
21 SI          .2840  +-    .0710
22 SN          .0000  +-    .0000
23 SR          .0000  +-    .0000
24 TI          .0101  +-    .0025
25 V           .0003  +-    .0001
26 ZN          .0000  +-    .0000
27 C           .0489  +-    .0122
28 NA          .0175  +-    .0044
29 NO3         .0002  +-    .0001
30 RB          .0000  +-    .0000
31 SE          .0000  +-    .0000
```

```
WHICH SOURCE DO YOU WANT?
GIVE SOURCE #
>
WHAT DO YOU WANT TO SEE?
SOURCE SIGNATURE, RECEPTOR CONCENTRATIONS, OR CODES?
OR ARE YOU DONE?
>DONE
ENTER COMMAND
```

Since the user only wanted to look at the Road Dust source signature, he gave a RETURN when asked for the next source. Furthermore, since he was finished examining input data, he returned to command mode.

Now the user employes the INITIAL command to restore the original selection of sources and species for the coarse size fraction. This returns the coarse source and species lists to their condition at the end of the initialization phase.

```
>INITIAL
SIZE IS COARSE
ENTER COMMAND
```

Now the user does a CMB analysis on the coarse fraction of the "Background" site without using the ridge option. Note that the "ridge" results and the least squares solution are identical.

```
>CMB
DO YOU WANT RIDGE SOLUTIONS?
>N
DO YOU WANT TO USE EFFECTIVE VARIANCES?
>N
DO YOU WANT TO INCLUDE THE INTERCEPT IN THE MODEL?
>N
```

```
CMB SITE: BACKGROUND       YEAR: 81   DATE: 0229      FRACTION: COARSE
SAMPLE DURATION: 12 WITH START HOUR:  7  BACKGROUND: NO    EFF VAR: NO
---------RIDGE REGRESSION--------    -----WEIGHTED LEAST SQUARES-----
  R-SQUARE: .9553   RIDGE K= .000             R-SQUARE: .9553
---SOURCE----------UG/M3---------    -------UG/M3----------VIF-------
  INTERCEPT       .000+-    .000             .000+-    .000
 1 SOIL         80.412+-  80.592           80.412+-  80.592  110.800
 2 RD DUST       5.407+-   8.682            5.407+-   8.682   27.837
 3 SEA SALT       .863+-   1.132             .863+-   1.132  691.696
 5 AUTO CAT     54.731+-  69.153           54.731+-  69.153  420.117
 6 AUTO           .850+-    .117             .850+-    .117    1.109
 7 JET AIR     -17.418+-  53.437          -17.418+-  53.437   31.827
 9 DIST OIL    -13.134+-  18.948          -13.134+-  18.948  187.619
10 RES GAS     -50.557+-  67.151          -50.557+-  67.151  350.204
11 COAL        -15.310+-  21.876          -15.310+-  21.876   81.796
12 KRAFT RB    -10.988+-  13.717          -10.988+-  13.717  366.998
13 ELARCFRN      2.736+-   3.373            2.736+-   3.373 1338.700
14 FERRMNFR     -9.637+-  11.824           -9.637+-  11.824 1205.257
16 CEMENT       11.503+-   9.054           11.503+-   9.054    9.787
17 PET FCC      -2.459+-  14.132           -2.459+-  14.132    4.676
TOTAL:          37.000+-  21.769           37.000+-  21.769
MEASURED CONCENTRATION FINE/COARSE/TOTAL:
  28.00000+-   3.000/  37.00000+-   4.000/  65.00000+-   5.000
PRESS RETURN TO CONTINUE OR ENTER C FOR NEXT COMMAND
>C
ENTER COMMAND
```

Since the user did not ask for ridge solutions, the "ridge" solution on the left is identical to the least squares solution on the right. The user also chose not to include the intercept in the model. Therefore, the intercept is set exactly to zero. It is apparent from the negative values with large magnitudes and the large standard errors that conventional weighted least squares is inadequate to handle this complex set of sources. It is clear from the variance inflation factors that this case is strongly affected by multicollinearity. As is discussed in Section 2, reducing the number of sources and using the ridge feature are two possible approaches for obtaining a reasonable solution.

Now the user has completed his session and enters the EXIT command to end it.

```
>EXIT
```

The session is now over.

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APPENDIX A

SOURCE PROGRAM LISTINGS

This appendix gives the FORTRAN source program listings of the CMB main program and subprograms. These programs and their functions are as follows:

MAIN	Program control and output
CMBR	Perform CMB analysis
FETCH	Search receptor concentration data file for selected site/date
INV1	Matrix inversion
COARS	Compute coarse fraction from Total and Fine fractions
PERC	Compute component percentages

TABLE A.1 CMB MAIN PROGRAM

```
C
C  PROGRAM CMB MAIN
C
C
C
C  THIS PROGRAM WAS ADAPTED FROM THE CMBDEQ
C PROGRAM DEVELOPED FOR THE STATE OF OREGON DEQ
C BY THE OREGON GRADUATE CENTER FOR STUDY AND RESEARCH.
C THE PROGRAM IS BASED ON THE WORK OF DR. J. WATSON'S CEB2 CODE
C AS MODIFIED BY D. TORKELSON  AS THE CMBDEQ CODE. THIS
C ADAPTATION WAS DEVELOPED BY J. CORE AND W. HAMILTON
C OF THE US EPA, OAQPS,RTP. N. CAROLINA,1981.
C THE PROGRAM WAS ORIGIONALLY WRITTEN FOR THE PRIME 350
C AND ADAPTED TO THE EPA'S SPERRY UNIVAC 1100 SYSTEM.
C  PROGRAM VARIABLES
C AND NECESSARY INPUT/OUTPUT FILES ARE DESCRIBED BELOW.
C
C  IN 1982, THE CMB MAIN PROGRAM AND THE SUBPROGRAM
C FETCH WERE MODIFIED AND ENHANCED. THE NEW
C SUBPROGRAM CMBR REPLACED CEB2,
C THEREBY ADDING A RIDGE REGRESSION OPTION.
C THIS WORK WAS DONE UNDER CONTRACT TO US EPA
C BY DR. H.J. WILLIAMSON AND DR. D.A. DUBOSE
C RADIAN CORP. AUSTIN,TEXAS
C EPA PROJECT OFFICER:W.P. FREAS
C
C
C
C *********************************************************************
C
C        REQUIRED INPUT FILES-
C
C    UNIT2, SONM - FILE OF  SOURCE CODES AND
C               SOURCE MNEMONICS. THIS FILE DEFINES THE
C               SOURCES IN THE WORKING SOURCE MATRIX.
C
C    UNIT3, PONM - FILE OF  POLLUTANT CODES AND
C              POLLUTANT MNEMONICS. THIS FILE DEFINES THE
C              POLLUTANTS IN THE WORKING SOURCE MATRIX.
C
C    UNIT7, SORF - FILE OF FRACTIONAL POLLUTANT COMPOSITIONS
C              FOR FINE FRACTION SOURCES SIGNATURES
C
C    UNIT8, SORC - FILE OF FRACTIONAL POLLUTANT COMPOSITIONS
C              FOR COARSE FRACTION SOURCES SIGNATURES
C
C    UNIT13, DATA - FILE OF FINE AND TOTAL FRACTION AMBIENT DATA
C                 RECEPTOR CONCENTRATION DATA
```

TABLE A.1 CMB MAIN PROGRAM (CONTINUED)

```
C
C
C      OUTPUT DISK FILES-
C
C
C    UNIT11, CMBOUT - FILE OF FINE, COARSE AND TOTAL
C               CMB RESULTS INCLUDING CHEMICAL AND FIT DATA.
C               GENERAL PRINT FILE
C               OPTIONAL OUTPUT FROM COMMANDS PMATRIX,PCOMP,PSOLN
C
C    UNIT  9, SUMMRY - FILE OF SUMMARIZED FINE , COARSE AND TOTAL
C               SOURCE COTRIBUTIONS
C              SUMMARY PRINT FILE
C
C    UNIT12, MAGSTO - FILE OF INPUT CARD DATA PLUS MASS AND
C               POLLUTANT CONTRIBUTIONS FOR EACH SOURCE.
C          USER FOLLOW UP FILE
C
C   UNIT10,TEMP - FILE OF TEMPORARY INPUT DATA STORAGE
C
C  INTERACTIVE TERMINAL FILES
C
C   UNIT5 - TERMINAL READ
C
C   UNIT6 - TERMINAL WRITE
C **********************************************************************
C
C
C ************************VARIABLE NAMES**************************
C
C   WORD HOLDER DATA ARRAYS
C  ELMENT(IEL)-ELEMENT MNEMONICS
C  SOUNAM(JSOURC)-SOURCE MNEMONICS
C  COMAND(ICMND)-COMMANDS
C  COMND1-COMMAND READ FROM SCREEN
C  SIZNAM-SAMPLE FRACTION DESCRIPTION
C  YBACK- CURRENT BACKGROUND SUBTRACTION INDICATOR
C  TEMPN- TEMPORARY NAME MATCHING HOLDER
C  STNM-CURRENT SITE NAME
C  BSTNM-CURRENT BACKGROUND SITE NAME
C
C
C  SOURCE COMPOSITION ARRAYS
C  A(IEL,JSOURC,ISIZ)-SOURCE COMPOSITIONS
C  UA(IEL,JSOURC,ISIZ)-UNCERTAINTIES OF A
C  SCODE(JSOURC)- SOURCE CODES
C  PCODE(IEL)- POLLUTANT CODES
C
```

TABLE A.1 CMB MAIN PROGRAM   (CONTINUED)

```
C
C  COUNTERS AND LIMITS
C  I-GENERAL COUNTER
C  IEL-ELEMENT COUNTER
C  KEL-FITTING ELEMENT COUNTER
C  LEL-ELEMENT DELETE COUNTER
C  NEL-TOTAL NUMBER OF SOURCE QUANTIFIED ELEMENTS
C  MEL-NUMBER OF FITTING ELEMENTS
C  JSOURC-SOURCE COUNTER
C  KSOURC-FITTING SOURCE COUNTER
C  LSOURC-SOURCE DELETE COUNTER
C  NSOURC-TOTAL NUMBER OF SOURCES
C  MSOURC-NUMBER OF FITTING SOURCES
C  IFLAG-METHOD FLAG COUNTER(INVERSION ERROR)
C  ICMND-COMMAND COUNTER
C  NCMND-TOTAL NUMBER OF COMMANDS
C  MELMAX-MAXIMUM NUMBER OF FITTING ELEMENTS
C  MSOMAX-MAXIMUM NUMBER OF FITTING SOURCES
C  MSOMIX-MSOMAX LESS ONE TO ALLOW FOR INTERCEPT
C
C
C
C
C  SAMPLE IDENTIFICATION VARIABLES
C  CMBID- UNIQUE DATA SET NUMBER OR NAME
C  UDUR-SAMPLING DURATION IN HOURS
C  USTART-SAMPLING START HOUR
C
C
C  OPERATIONS VARIABLES
C  UCNC(IEL,ISIZ)-URBAN OPERATIONS MEASURED CONCENTRATIONS
C  UUCNC(IEL,ISIZ)-UNCERTAINTY OF UCNC
C  CLCN(IEL,ISIZ)-CALCULATED CONCENTRATION
C  UCLCN(IEL,ISIZ)-UNCERTAINTY OF CLCN
C  UFMSS-URBAN FINE MASS LOADING
C  UUFMSS-UNCERTAINTY OF UFMSS
C  UCMSS- COARSE MASS
C  UUCMSS - UNCERTAINTY
C  UTMSS- TOTAL MASS
C  UUTMSS- UNCERTAINTY
C  MFLAG(IEL,3)-MISSING DATA FLAG FOR EACH ELEMENT AND SIZE
C
C
C  BACKGROUND SUBTRACTION VARIABLES
C  -SAME AS URBAN PREFACED WITH A 'B'
C
C
C
```

TABLE A.1 CMB MAIN PROGRAM (CONTINUED)

```
C  TEMPORARY OUTPUT VARIABLES
C  PCNT-PERCENT
C  UPCNT-UNCERTAINTY PERCENT
C  FPCNT-FINE PERCENT
C  UFPCNT-UNCERTAINTY
C  CPCNT-COARSE PERCENT
C  UCPCNT-UNCERT
C  TPCNT-TOTAL PERCENT
C  UTPCNT-UNCERTAINTY
C  X-GENERAL
C  UX-GENERAL
C  TX-GENERAL TOTALS
C  UTX-UNCERTAINTY
C  RATIO-RATIO OF CALCULATED TO MEASURED
C  URATIO-UNCERTAINTY OF RATIO
C
C
C
C  FIT INITIALIZATION ARRAYS
C  INITEL(IEL)-INITIAL FITTING ELEMENTS
C  INITSO(JSOURC)-INITIAL FITTING SOURCES
C  IMEL-NUMBER OF INITIAL FITTING ELEMENTS
C  IMSO-NUMBER OF INITIAL FITTING SOUCES
C
C  MISC.
C  ELFT(IEL,ISIZ)-ELEMENT FITTING FLAG
C  ELHOLD(KEL,ISIZ)-ELEMENT FITTING PLACE HOLDER
C  SOUFT(JSOURC,ISIZ)-SOURCE FITTING FLAG
C  SOHOLD(KSOURC,ISIZ)-SOURCE FITTING PLACE HOLDER
C  IRTN-GO TO STATEMENT VARIABLE
C  JRTN-GO TO STATEMENT VARIABLE
C   UNITX-FORTRAN FILE UNIT NUMBER
C  X-GENERAL REAL NUMBER
C  ICNTRL-AUTOFIT/SELECT CONTROL CODE FOR FETCH
C  SEL(ISIZ)-ELEMENTAL SOURCE CONTRIBUTIONS
C  USEL(ISIZ)-UNCERTAINTY
C  ISCTR-PRINTED SOURCE COUNTER
C  ISHOLD(ISCTR)-ARRAY POSITIONS OF PRINTED SOURCES
C  IBACK-CURRENT BACKGROUND SUBTRACTION INDICATOR
C  DUM(20)-SCRATCH VECTOR
C  SAVE-AUTOFIT TITLE LINE HOLDER
C
C
C         BOOKKEEPING
C
C ANS-ANSWER TO PROGRAM QUERIES
C CHK-ANSWER TO PROGRAM QUERIES
C IBACK-BACKGROUND SUBTRACTION STATUS FLAG
```

TABLE A.1 CMB MAIN PROGRAM (CONTINUED)

```
C IWIDE-TERMINAL LINE WIDTH FLAG
C LASTID-HOLDER FOR CMBID IN PCOMP
C LOOP  -CYCLING STATUS FLAG IN PMATRIX
C MANY-LINE WIDTH CONTROL INDEX
C MORE-LINE WIDTH CONTROL INDEX
C NOSKIP-CMB PARAMETER CONTROL FLAG CONTROLLED BY AUTOFIT
C OLDID-HOLDER FOR CMBID TO PREVENT TOTALING FINE AND COARSE
C       OF DIFFERENT SITES IN WRITE
C PNAM-ARRAY FOR CMBID'S IN PCOMP
C SITE-SITE CODE        :
C YEAR-YEAR             : COMPONENTS OF CMBID
C DATE-MONTH AND DAY    :
C SPACE-DUMMY CHARACTER FOR READ
C TEMPID-TEMPORARY HOLDER FOR CMBID CHECK
C
C
C
C CMBR SUBPROGRAM ARGUMENTS AND RELATED VARIABLES
C
C AP-CMBR WORK SPACE
C C-RECEPTOR CONCENTRATION VECTOR
C CWT-WEIGHT FOR SELECTING RIDGE SOLUTIONS
C CWT10-TEMPORARY HOLDER FOR CWT VALUE
C EFVAR-EFFECTIVE VARIANCE FLAG
C SELK-LEAST SQUARES SOLUTION
C F-SOURCE SIGNATURE MATRIX
C IA-CMBR WORK SPACE
C INTCEP-INTERCEPT OPTION FLAG
C IS-CMBR WORK SPACE
C ITM-CMBR WORK SPACE
C KINDEX-INDEX OF SELECTED BEST RIDGE SOLUTION
C R2LS-R-SQUARE FOR LEAST SQUARES SOLUTION
C RIDGE  -RIDGE OPTION FLAG
C S-CMBR WORK SPACE
C SAINT-SELECTED RIDGE SOLUTION INTERCEPT
C SAINTO-LEAST SQUARES SOLUTION VECTOR
C SAS-RIDGE SOLUTION MATRIX
C SAA-RIDGE SOLUTION STANDARD ERROR MATRIX
C SET-STANDARD ERROR OF CALCULATED TOTAL AEROSOL
C SETLS-STANDARD ERROR OF CALCULATED TOTAL AEROSOL(LEAST SQUARES)
C SF-STANDARD ERROR OF SOURCE SIGNATURE MATRIX
C SOLD-CMBR WORK SPACE
C SR2-R-SQUARE FOR SELECTED RIDGE SOLUTION
C SSET-STANDARD ERROR OF CALCULATED TOTAL AEROSOL
C SX-CMBR WORK SPACE
C USAINT-UNCERTAINTY OF SAINT (RIDGE SOLN INTERCEPT)
C USAINO-UNCERTAINTY OF SAINTO (LEAST SQUARES INTERCEPT)
C VELK-STANDARD ERROR OF LEAST SQUARES SOLUTION
```

TABLE A.1 CMB MAIN PROGRAM (CONTINUED)

```
C TM-WORK VECTOR FOR CMBR
C TOTALA-TOTAL AEROSOL MASS
C V-STANDARD ERRORS OF RECEPTOR CONCENTRATION VECTOR
C VIF-VARIANCE INFLATION FACTOR
C VIFELK-VIF ORGANIZED BY SOURCE INDECIES
C VK-VECTOR OF K-VALUES FOR RIDGE REGRESSION
C XMEAN-USED BY CMBR FOR SOURCE MEANS
C XP-USED BY CMBR FOR X MATRIX
C XPX-USED BY CMBR FOR X'X MATRIX
C XPXK-USED BY CMBR FOR X'X MATRIX(INVERSE)
C XPY-USED BY CMBR FOR X'Y VECTOR
C YP-USED BY CMBR FOR Y VECTOR
C
C
C  CHARACTER TEST CONSTANTS
C BLANK,IBLANK-BLANK '        '
C ISTAR-PRINT FLAGS ' ' '*'
C QUOTA-'A'      QUOTB-'B'       QUOTC-'C' (COARSE,CODES)
C QUOTD-'D' (DONE)
C QUOTOL-'TOTAL'       QUOTR-'R' (RECEPTOR)
C QUOTS-'S' (SOURCE,STOP)       STAR-ASTERISK '*'
C YESY-'Y' (YES)
C
C **********************************************************************
C
C
C
C
C  SPECIFICATION AND DIMENSION
C
       REAL*8 COMAND(20),SIZNAM(3),SOUNAM(35),ELMENT(35),TEMPN,
      *COMND1,QUOTOL
CHARACTER VARIABLES
       INTEGER*4 CHK,ELFT(35,2),SOUFT(35,2),ANS,
      *YBACK(2),TYPE,YESY,
      * MFLAG(35,3),MFLAGB(35,3),DUM(20),ISTAR(3),
      * STAR,QUOTC,QUOTA,QUOTB,QUOTS,SPACE,CMBID(5),BACKID(5),
      * OLDID(5),QUOTR,QUOTD,TEMPID(6),LASTID(6),
      *SAVE(5), FLAG(8,3),YEAR,BYEAR,SITE(3),BSITE(3),DATE,BDATE
C
C   NUMERIC VARIABLE SPECS
       INTEGER*4 ELHOLD(35,2),SOHOLD(35,2),
      *INITEL(21),INITSO(16),IMEL,IMSO,
      *MEL1(2),MSORC1(2), USTART,UDUR,
      *UNIT,NEL,NSOURC,MELMAX,MSOMAX,BSTART,BDUR,
      *IRTN,JRTN,IEL,JSOURC,NCMND,I,KEL,LEL, ICMND,UNIT6,UNIT10,UNIT13,
      *UNIT12,MEL,MSOURC,KSOURC,LSOURC,
      *EFVAR,SIZ,UNIT5,UNITX,UNIT9,
```

TABLE A.1 CMB MAIN PROGRAM   (CONTINUED)

```
     *SCODE(35),PCODE(35),ISHOLD(35),UNIT11,
     *TEMPC, IFLAG(3),RIDGE
C
C
      REAL*4 A(35,35,2),UA(35,35,2),SEL(2),USEL(2),
     *USORC(35,3),UUSORC(35,3),UCNC(35,3),UUCNC(35,3),
     *CLCN(35,3),UCLCN(35,3),UFMSS,UUFMSS,RATIO,URATIO,
     *TX,UTX,X,UX,PCNT,UPCNT,UTMSS,UUTMSS,UCMSS,UUCMSS,
     *BFMSS,UBFMSS,UBTMSS,BTMSS,BCMSS,UBCMSS,BCNC(35,3),UBCNC(35,3),
     *  SELK(35),UELK(35),VIFELK(35),SAINT(3),SET(3),USAINT(3)
C
C
C  CHEMICAL ELEMENT BALANCE ARRAYS
C
C  STORAGE FOR CMB SUBROUTINE (17 SOURCES, 21 SPECIES)
C  THE INTERCEPT COUNTS AS A SOURCE
      REAL F(21,17),C(21),V(21),SF(21,17),  VK(31),   W(21),
     * YP(21),XP(21,17),XMEAN(17), XPX(17,17),
     *  XPXK(17,17),XPY(17),SX(17),S(17),TM(21),AP(17),SOLD(17),
     * VIF(17),SAS(17,31),SAA(17,31),SSET(2)
      INTEGER IS(17),IA(17),ITM(21),PNAM(17,6)
      REAL*8 BLANK
C
C
C  EQUIVALENCE STATEMENT
      EQUIVALENCE (IS,S),(IA,AP),(ITM,TM)
      EQUIVALENCE (IBLANK,BLANK),(STAR,ISTAR(2)),
     *   (XPXK,PNAM),
     * (CMBID,SITE),(CMBID(4),YEAR),(CMBID(5),DATE),
     * (BACKID,BSITE),(BACKID(4),BYEAR),(BACKID(5),BDATE)
C
C
C COMMON
      COMMON /F/ PCODE,SCODE,NEL
C
C
C  DATA STATEMENTS
      DATA YBACK/'YES ','NO  '/,YESY/'Y'/
C
      DATA BLANK/'        '/,QUOTC,QUOTA,QUOTB,QUOTS/
     *  'C','A','B','S'/,QUOTOL/'TOTAL'/,
     *  QUOTR,QUOTD/'R','D'/
      DATA COMAND/
     *'HELP    ',
     *'AE      ','DE      ','AS      ','DS      ','CMB     ',
     *'PSOLN   ','PINFO   ','PDATA   ','WRITE   ',
     *'INITIAL ','PMATRIX ','PCOMP   ','RESUME  ',
     *'AUTOFIT ','SELECT  ','BACKOUT ',
     *'BACKIN  ','EXIT    ','SIZE    '/
C
      DATA VK    /0.0,0.005,0.01,0.015,0.020,0.025,
     * 0.030,0.035,0.040,0.045,0.050, 0.060,0.070,0.080,0.090,
     * 0.100,  0.12,0.14,0.16,0.18,0.20,   0.24,0.28,0.32,0.36,
     *  0.40,   0.48,0.56,0.64,0.72,0.80   /
C
C
      DATA SIZNAM/' FINE   ','COARSE  ','TOTAL   '/
C
      DATA FLAG/'    ','    ','    ','    ','    ','    ','    ','
     *          '--- ',' CEB',' MAT','RIX ','IS S','INGU','LAR ',' ---'
     *          '--- ',' NON',' CON','VERG','ENT ','SOLU','TION',' ---'.
      DATA ISTAR/'    ','*   ','**  '/,NOSKIP/0/
C  INITIALIZATION OF STARTING PARAMETERS
C SET OUTPUT UNIT NUMBERS
      UNIT5=5
      UNIT6=6
      UNIT9=9
      UNIT10=10
      UNIT11=11
      UNIT12=12
      UNIT13=13
C  MAXIMUM NUMBER OF FITTING ELEMENTS
      MELMAX=21
C  MAXIMUM NUMBER OF FITTING SOURCES
      MSOMAX=17
      MSOMIX=MSOMAX-1
C  SET RETURN STATEMENT
      IRTN=1
C  NUMBER OF COMMANDS
      NCMND=20
C DATA SEARCH CONTROL SET TO SELECT MODE
      ICNTRL=4
C BACKGROUND SUBTRACT SET TO 'NONE'
      IBACK=2
C
C
C    - CREATE WORKING SOURCE MATRICES -
C
C CODE SOURCE NAMES AND POSITIONS FROM SONM FILE
110   NSOURC=0
      DO 140 I=1,35
      SOUNAM(I)=BLANK
      SCODE(I)=0000
115   READ(2,120,ERR=130,END=150)TEMPC,TEMPN
120   FORMAT(I2,2X,A8)
      SOUNAM(I)=TEMPN
```

TABLE A.1 CMB MAIN PROGRAM (CONTINUED)

```
      SCODE(I)=TEMPC
      NSOURC=NSOURC+1
      GO TO 140
C ERROR MESSAGE- FORMAT MISMATCH
130   WRITE(UNIT6,135)
135   FORMAT(1H ,'AN INPUT CARD DID NOT MATCH PROPER FORMAT'/
     *1X,'IN FILE SONM AND WAS IGNORED. CHECK THIS AT UPCOMING '/
     *1X,'VERIFY POINT')
      GO TO 115
140   CONTINUE
C CODE POLLUTANT NAMES AND POSITIONS FROM PONM FILE
150   NEL=0
      KINDEX=0
      DO 190 I=1,35
      ELMENT(I)=BLANK
      PCODE(I)=000
160   READ(3,170,ERR=180,END=200)TEMPC,TEMPN
170   FORMAT(I2,2X,A8)
C DO NOT CODE IF POLLUTANT IS MASS CONCENTRATION
      IF(TEMPC.NE.01)GO TO 175
      TEMPN=QUOTOL
      KINDEX=1
175   ELMENT(I)=TEMPN
      PCODE(I)=TEMPC
      NEL =NEL+1
      GO TO 190
C ERROR MESSAGE- FORMAT MISMATCH
180   WRITE(UNIT6,185)
185   FORMAT(1H ,'AN INPUT CARD DID NOT MATCH PROPER FORMAT'/
     *1X,'IN FILE PONM AND WAS IGNORED. CHECK THIS AT UPCOMING '/
     *1X,'VERIFY POINT')
      GO TO 160
190   CONTINUE
200   IF(KINDEX.EQ.1)GO TO 201
      PCODE(I)=1
      ELMENT(I)=QUOTOL
      NEL=NEL+1
C INITIALIZE SOURCE MATRICES
201   DO 210 ISIZ=1,2
      DO 210 I=1,NSOURC
      DO 210 J=1,NEL
      A(J,I,ISIZ)=0.000E-00
      UA(J,I,ISIZ)=0.001E-02
210   CONTINUE
C CODE MATRICES
      DO 270 ISIZ=1,2
      IUNIT=ISIZ+6
215   READ(IUNIT,220,ERR=232,END=270)ISCODE,IPCODE,X,UX
```

```
220   FORMAT(I2,2X,I2,2X,F8.6,2X,F8.6)
      IF(IPCODE.EQ.1)WRITE(UNIT6,221)IUNIT
  221 FORMAT(' **WARNING** POLLUTANT CODE 1 IN DATA ON UNIT ',
     * I2,/' CODE 1 IS RESERVED FOR TOTAL AEROSOL')
C MATCH SCODES
      DO 230 J=1,NSOURC
      IF(ISCODE.EQ.SCODE(J))GO TO 240
230   CONTINUE
C ERROR MESSAGE - NO SCODE MATCH
232   IF(ISIZ.EQ.1)WRITE(UNIT6,234)
234   FORMAT(1H ,'FORMAT MISMATCH OR SOURCE CODE NOT IDENTIFIED FOR '/
     *1X,'AN INPUT CARD IN SORF FILE . CARD IGNORED.')
      WRITE(UNIT6,235)ISCODE
  235 FORMAT(1X,'SOURCE CODE :',I3)
      IF(ISIZ.EQ.2)WRITE(UNIT6,236)
236   FORMAT(1H ,'FORMAT MISMATCH OR SOURCE CODE NOT IDENTIFIED FOR '/
     *1X,'AN INPUT CARD IN SORC FILE . CARD IGNORED.')
      GO TO 215
C MATCH PCODES
240   DO 250 K=1,NEL
      IF(IPCODE.EQ.PCODE(K))GO TO 260
250   CONTINUE
C ERROR MESSAGE - NO MATCH
      IF (ISIZ.EQ.1)WRITE(UNIT6,252)SOUNAM(J)
252   FORMAT(1H ,'AN UNIDENTIFIED POLLUTANT CARD WAS FOUND IN'/
     *1X,'FILE SORF , SOURCE-',A5)
      IF(ISIZ.EQ.2)WRITE(UNIT6,254)SOUNAM(J)
254   FORMAT(1H ,'AN UNIDENTIFIED POLLUTANT CARD WAS FOUND IN'/
     *1X,'FILE SORC , SOURCE-',A5)
      GO TO 215
260   A(K,J,ISIZ)=X
      UA(K,J,ISIZ)=UX
      GO TO 215
270   CONTINUE
C  ADD TOTAL AEROSOL ELEMENT
      DO 272 K=1,NEL
      IF(PCODE(K).EQ.1) GO TO 273
  272 CONTINUE
  273 DO 274 ISIZ=1,2
      DO 274 J=1,NSOURC
      A(K,J,ISIZ)=1.0
      UA(K,J,ISIZ)=0.000001
  274 CONTINUE
C WRITE DATA TO SCREEN FOR INSPECTION
  278 WRITE(UNIT6,300)
  300 FORMAT(1X,'WOULD YOU LIKE TO LOOK AT THE SOURCE AND SPECIES '
     *'LISTS?'
     * ,/,2X,'TYPE YES OR NO.')
```

TABLE A.1 CMB MAIN PROGRAM (CONTINUED)

```
301   READ(UNIT5,28001,ERR=278)ANS
302   FORMAT(A3)
      IF(ANS .NE.  YESY )GO TO 335
      GO TO 304
304   WRITE(UNIT6,310)
310   FORMAT(1H ,'SOURCE SIGNATURE MATRICES ARE CODED AS FOLLOWS',/,
     *1X,'SOURCES:',/,
     *1X,'SOURCE #      SOURCE NAME',/)
      DO 315 I=1,NSOURC
      WRITE(UNIT6,312)I,SOUNAM(I)
312   FORMAT(3X,I2,11X,A8)
315   CONTINUE
      WRITE(UNIT6,320)
320   FORMAT(1H ,/,1X,'SPECIES:',/,
     *1X,'SPECIES #    SPECIES NAME     ')
      DO 330 I=1,NEL
      WRITE(UNIT6,312)I,ELMENT(I)
330   CONTINUE
C
C
C
C
C        - SET UP INITIAL AUTOFIT POLLUTANTS AND SOURCES -
C
C
C
C  INITIALIZE FIT FLAGS
   335 DO 340 IEL=1,NEL
      ELHOLD(IEL,1)=0
      INITEL(IEL)=0
340    ELFT(IEL,1)=IBLANK
      DO 350 JSOURC=1,NSOURC
      SOHOLD(JSOURC,1)=0
      INITSO(JSOURC)=0
350   SOUFT(JSOURC,1)=IBLANK
C INPUT INITIAL AUTOFIT SOURCES AND ELEMENTS
360   WRITE(UNIT6,365)
365   FORMAT(1H ,'PLEASE INPUT INITIAL FITTING INFORMATION')
      IMSO=0
      DO 370 I=1,NSOURC
366   WRITE(UNIT6,367)I
367   FORMAT(1HO,'INITIAL SOURCE ',I2,': XX')
      READ(UNIT5,2420,ERR=366)INITSO(I),SPACE
      IF (SPACE.EQ.IBLANK)INITSO(I)=INITSO(I)/10
      IF(INITSO(I).EQ.0)GO TO 380
      IF(INITSO(I).EQ.-1)GO TO 372
      IMSO=IMSO+1
370   CONTINUE
```

TABLE A.1 CMB MAIN PROGRAM (CONTINUED)

```
      GO TO 380
  372 IMSO=MIN0(NSOURC,MSOMIX)
      DO 373 I=1,NSOURC
  373 INITSO(I)=I
  380 WRITE(UNIT6,381)
  381 FORMAT(' INITIAL SOURCES')
      DO 390 I=1,IMSO
      J=INITSO(I)
      WRITE(UNIT6,425)J,SOUNAM(J)
390   CONTINUE
      IMEL=0
      WRITE(UNIT6,400)
400   FORMAT(' ',/,1X,'PLEASE INPUT SPECIES')
      DO 410 I=1,NEL
403   WRITE(UNIT6,404)I
404   FORMAT(1H ,'INITIAL SPECIES ',I2,': XX')
      READ(UNIT5,2420,ERR=403)INITEL(I),SPACE
      IF(SPACE.EQ.IBLANK)INITEL(I)=INITEL(I)/10
      IF(INITEL(I).EQ.0)GO TO 420
      IF(INITEL(I).EQ.-1)GO TO 411
      IMEL=IMEL+1
410   CONTINUE
      GO TO 420
  411 IMEL=MIN0(NEL,MELMAX)
      DO 412 I=1,IMEL
  412 INITEL(I)=I
  420 WRITE(UNIT6,421)
  421 FORMAT(' INITIAL SPECIES')
      DO 430 I=1,IMEL
      J=INITEL(I)
      WRITE(UNIT6,425)J,ELMENT(J)
425   FORMAT(' ',3X,I2,3X,A8)
430   CONTINUE
C OPERATOR DECISION- CORRECT INPUT OR CONTINUE
      WRITE(UNIT6,435)
435   FORMAT(' '/,1X,'ARE INITIAL SOURCES AND SPECIES CORRECT?')
      READ(UNIT5,28001)CHK
      IF(CHK.EQ.YESY)GO TO 441
      WRITE(UNIT6,442)
  442 FORMAT(' USE COMMANDS AE,DE,AS,DS FOR CHANGES.'/
     * ' OR, DO YOU WANT A FRESH START?')
      READ(UNIT5,28001)ANS
      IF(ANS.EQ.YESY)GO TO 360
  441 IRTN=0
      SIZ=1
  443 GO TO 4401
  444 IF(SIZ.GE.2)GO TO 445
      SIZ=2
```

TABLE A.1 CMB MAIN PROGRAM   (CONTINUED)

```
      GO TO 443
  445 IRTN=1
      WRITE(UNIT6,446)
  446 FORMAT(' THE "HELP" COMMAND LISTS COMMANDS')
      SIZ=1
      WRITE(UNIT6,3110) SIZNAM(SIZ)
C
C
450   REWIND UNIT10
      GO TO (500,2860,4120,4130,4132,4150,4250,4260,4270,4280),IRTN
C
C
C
C
C     - START OF GENERAL INTERACTIVE NETWORK -
C
C
C
C  COMMAND SEQUENCE
490   WRITE(UNIT6,495)
495   FORMAT(1H ,'COMMAND NOT EXECUTED.  TRY AGAIN')
500   WRITE(UNIT6,510)
510   FORMAT(1H ,'ENTER COMMAND')
      READ(UNIT5,520,ERR=490)COMND1
520   FORMAT(A8)
      DO 550 ICMND=1,NCMND
      IF(COMND1.EQ.COMAND(ICMND))GO TO 600
550   CONTINUE
      GO TO 490
C  BRANCHING
 600  GO TO(
     *1100,2400,2500,2600,2700,2800,
     *42000,3000,3200,3400,4400,
     *43000,52000,4000,
     *4099,4200,4600,4700,5000,3100
     *),ICMND
C
C
C
C      -HELP.  LIST AND DEFINE AVAILABLE COMMANDS
 1100 WRITE(UNIT6,1110)
 1110 FORMAT(1H ,
     *'HELP-LISTS THESE COMMANDS',/1H ,
     *' ',/1H ,
     *'---- DATA ACCESS AND SEQUENCING ----',/1H ,
     *'AUTOFIT-SEQUENCES AUTOMATICALLY TO NEXT DATA SET',/1H ,
     *'RESUME-RESUME AUTOFIT',/1H ,
     *'SELECT-SELECT DATA SET FOR CMB',/1H ,
```

TABLE A.1 CMB MAIN PROGRAM   (CONTINUED)

```
     *'SIZE-CHANGE SIZE FRACTION'/' ',
     *'EXIT-CLOSE FILES AND LEAVE',/1H ,
     *' ',/1H ,
     *'---- CMB OPERATIONS ----',/1H ,
     *'AE-ADD A SPECIES TO THE FIT',/1H ,
     *'DE-DELETE A SPECIES FROM THE FIT',/1H ,
     *'AS-ADD A SOURCE TO THE FIT',/1H ,
     *'DS-DELETE A SOURCE FROM THE FIT',/1H ,
     *'CMB-PERFORM CMB:   OPTIONS ARE RIDGE & EFFECTIVE VARIANCE'/' ')
      WRITE(UNIT6,1120)
1120  FORMAT(1H ,
     *' ',/1H ,
     *'---- SCREEN DISPLAY ----',/1H ,
     *'PINFO-PRINT CURRENT STATUS ON SCREEN',/1H ,
     *'PDATA-PRINT CURRENT CMB RESULTS ON SCREEN',/1H ,
     *'PMATRIX-PRINT SOURCE SIGNATURE, RECEPTOR CONCENTRATIONS,'/
     * '  OR SOURCE AND SPECIES CODE LISTS'/' ',
     *'PSOLN-PRINT ALL RIDGE SOLUTIONS',/' ',
     *'PCOMP-PRINT COMPUTED AVERAGES OF CMB SERIES',/' ',
     *' ',/1H ,
     *'---- DATA STORAGE ----',/1H ,
     *'WRITE-WRITE PRESENT CMB RESULTS TO FULL PRINTOUT,',/1H ,
     *'        SUMMARY,AND USER FOLLOWUP STORAGE FILES')
      WRITE(UNIT6,1140)
1140  FORMAT(1H ,
     *' ',/1H ,
     *'---- BACKGROUND SITE OPERATIONS ----',/1H ,
     *'BACKOUT-SELECT AND SUBTRACT A BACKGROUND DATA SET',/1H ,
     *'BACKIN-ELIMINATE CURRENT BACKGROUND SUBTRACTION')
      WRITE(UNIT6,1150)
 1150 FORMAT(//' SELECT SHOULD NORMALLY BE THE FIRST COMMAND')
      GO TO (500,2860,4120,4130,4132,4150,4250,4260,4270,4280),IRTN
C
C
C
C
C      -AE.  ADD AN SPECIES TO THE FIT
2400  JRTN=1
      WRITE(UNIT6,3110)SIZNAM(SIZ)
      GO TO 2410
2405  WRITE(UNIT6,2407)
2407  FORMAT(1H ,'IMPROPER CODE, TRY AGAIN')
2410  WRITE(UNIT6,2415)
2415  FORMAT(1H ,'INPUT CODE OF ADDED SPECIES')
      READ(UNIT5,2420,ERR=2405)IEL,SPACE
2417  IF(IEL.EQ.0)GO TO (500,2860,4120,4130,4132,4150,4250,4260,
     *4270,4280),IRTN
2420  FORMAT( I2,T2,A1)
```

TABLE A.1 CMB MAIN PROGRAM (CONTINUED)

```
      IF(SPACE.EQ.IBLANK)IEL=IEL/10
      IF(IEL.LT.1.OR.IEL.GT.NEL)GO TO 2405
C  CHECK TO SEE IF THIS IS ALREADY A FITTING SPECIES
      IF(ELFT(IEL,SIZ).EQ.IBLANK)GO TO 2430
      WRITE(UNIT6,2425)ELMENT(IEL)
2425  FORMAT(1H ,A8,' IS ALREADY A FITTING SPECIES')
      GO TO (2410,2510,2610,2710,3402),JRTN
2430  IF(MEL1(SIZ).EQ.MELMAX)GO TO 2480
      MEL1(SIZ)=MEL1(SIZ)+1
      MEL=MEL1(SIZ)
      ELFT(IEL,SIZ)=STAR
      ELHOLD(MEL,SIZ)=IEL
      GO TO (2410,2510,2610,2710,3402),JRTN
2480  WRITE(UNIT6,2490)MELMAX, ELMENT(IEL)
2490  FORMAT(1H ,'MAXIMUM OF ',I2,' FITTING SPECIES EXCEEDED. ',
     :1X,A4,' NOT ADDED TO FIT')
      GO TO (500,2860,4120,4130,4132,4150,4250,4260,4270,4280),IRTN
C
C
C
C
C      -DE.  DELETE AN SPECIES FROM THE FIT
2500  JRTN=2
      WRITE(UNIT6,3110)SIZNAM(SIZ)
      GO TO 2510
2505  WRITE(UNIT6,2407)
2510  WRITE(UNIT6,2515)
2515  FORMAT(1H ,'INPUT CODE OF DELETED SPECIES')
      READ(UNIT5,2420,ERR=2505)IEL,SPACE
      IF(SPACE.EQ.IBLANK)IEL=IEL/10
2517  IF(IEL.EQ.0)GO TO (500,2860,4120,4130,4132,4150,4250,4260,
     *4270,4280),IRTN
      IF(IEL.LT.1.OR.IEL.GT.NEL)GO TO 2505
C CHECK TO SEE IF THIS IS A FITTING SPECIES ALREADY
      IF(ELFT(IEL,SIZ).EQ.STAR)GO TO 2530
2523  WRITE(UNIT6,2525)ELMENT(IEL)
2525  FORMAT(1H ,A8,' IS NOT A FITTING SPECIES')
      GO TO (2410,2510,2610,2710,3402),JRTN
2530  MEL=MEL1(SIZ)
      DO 2540 KEL=1,MEL
      IF(ELHOLD(KEL,SIZ).EQ.IEL)GO TO 2560
2540  CONTINUE
      GO TO 2523
2560  MEL1(SIZ)=MEL1(SIZ)-1
      MEL=MEL1(SIZ)
      ELFT(IEL,SIZ)=IBLANK
      DO 2570 LEL=KEL,MEL
      ELHOLD(LEL,SIZ)=ELHOLD(LEL+1,SIZ)
```

```
2570  CONTINUE
      GO TO (2410,2510,2610,2710,3402),JRTN
C
C
C
C
C      -AS.  ADD A SOURCE TO THE FIT
2600  JRTN=3
      WRITE(UNIT6,3110)SIZNAM(SIZ)
      GO TO 2610
2605  WRITE(UNIT6,2407)
2610  WRITE(UNIT6,2615)
2615  FORMAT(1H ,'INPUT CODE OF ADDED SOURCE')
      READ(UNIT5,2420,ERR=2605)JSOURC,SPACE
      IF(SPACE.EQ.IBLANK)JSOURC=JSOURC/10
2617  IF(JSOURC.EQ.0)GO TO (500,2860,4120,4130,4132,4150,4250,4260,
     *4270,4280),IRTN
      IF(JSOURC.LT.1.OR.JSOURC.GT.NSOURC)GO TO 2605
C CHECK TO SEE IF THIS IS ALREADY A FITTING SOURCE
      IF(SOUFT(JSOURC,SIZ).EQ.IBLANK)GO TO 2630
      WRITE(UNIT6,2625)SOUNAM(JSOURC)
2625  FORMAT(1H ,A8,' IS ALREADY A FITTING SOURCE')
      GO TO (2410,2510,2610,2710,3402),JRTN
2630  IF(MSORC1(SIZ).EQ.MSOMAX)GO TO 2680
      MSORC1(SIZ)=MSORC1(SIZ)+1
      MSOURC=MSORC1(SIZ)
      SOUFT(JSOURC,SIZ)=STAR
      SOHOLD(MSOURC,SIZ)=JSOURC
      GO TO (2410,2510,2610,2710,3402),JRTN
2680  WRITE(UNIT6,2690)MSOMAX,SOUNAM(JSOURC)
2690  FORMAT(1H ,'MAXIMUM OF ',I2,' FITTING SOURCES EXCEEDED. ',
     :1X,A8,' NOT ADDED TO FIT.')
      GO TO (500,2860,4120,4130,4132,4150,4250,4260,4270,4280),IRTN
C
C
C
C
C      -DS.  DELETE A SOURCE FROM THE FIT
2700  JRTN=4
      WRITE(UNIT6,3110)SIZNAM(SIZ)
      GO TO 2710
2705  WRITE(UNIT6,2407)
2710  WRITE(UNIT6,2715)
2715  FORMAT(1H ,'INPUT CODE OF DELETED SOURCE')
      READ(UNIT5,2420,ERR=2705)JSOURC,SPACE
      IF(SPACE.EQ.IBLANK)JSOURC=JSOURC/10
2717  IF(JSOURC.EQ.0)GO TO (500,2860,4120,4130,4132,4150,4250,4260,
     *4270,4280),IRTN
```

TABLE A.1 CMB MAIN PROGRAM   (CONTINUED)

```
      IF(JSOURC.LT.1.OR.JSOURC.GT.NSOURC)GO TO 2705
C  IS IT ALREADY A FITTING SOURC
      IF(SOUFT(JSOURC,SIZ).EQ.STAR)GO TO 2730
2723  WRITE(UNIT6,2725)SOUNAM(JSOURC)
2725  FORMAT(1H ,A8,' IS NOT A FITTING SOURCE')
      GO TO (2410,2510,2610,2710,3402),JRTN
2730  MSOURC=MSORC1(SIZ)
      DO 2740 KSOURC=1,MSOURC
      IF(SOHOLD(KSOURC,SIZ).EQ.JSOURC)GO TO 2760
2740  CONTINUE
      GO TO 2723
2760  MSORC1(SIZ)=MSORC1(SIZ)-1
      MSOURC=MSORC1(SIZ)
      SOUFT(JSOURC,SIZ)=IBLANK
      DO 2770 LSOURC=KSOURC,MSOURC
      SOHOLD(LSOURC,SIZ)=SOHOLD(LSOURC+1,SIZ)
2770  CONTINUE
      GO TO (2410,2510,2610,2710,3402),JRTN
C
C
C
C
C          -CMB.  PERFORM  CHEMICAL ELEMENT BALANCE
2800  NOSKIP=0
 2801 IF(NOSKIP.EQ.1)GO TO 28032
      WRITE(UNIT6,28000)
28000 FORMAT(' DO YOU WANT RIDGE SOLUTIONS?')
      READ(UNIT5,28001)ANS
28001 FORMAT(A1)
      IF(ANS.EQ.QUOTS)GO TO 28032
      RIDGE=0
      CWT=1.0
      IF(ANS.NE.YESY) GO TO 28020
      RIDGE=1
      WRITE(UNIT6,28010)
28010 FORMAT(' CMB WILL SELECT THE BEST RIDGE SOLUTION'/
     * ' DO YOU WANT TO SEE A SUMMARY OF THE OTHERS?')
      READ(UNIT5,28001)ANS
      IF(ANS.EQ.YESY)RIDGE=2
      WRITE(UNIT6,28015)
28015 FORMAT(' IN THE SELECTION OF THE BEST RIDGE SOLUTION, '
     * /' WHAT WEIGHT DO YOU WANT?  (DEFAULT=1.0)')
      READ(UNIT5,28016)CWTO
28016 FORMAT(F10.0)
      IF(CWTO.NE.0)CWT=CWTO
      WRITE(UNIT6,28017)CWT
28017 FORMAT(' WEIGHT IS',F20.9)
28020 WRITE(UNIT6,28021)
```

TABLE A.1 CMB MAIN PROGRAM   (CONTINUED)

```
28021 FORMAT(' DO YOU WANT TO USE EFFECTIVE VARIANCES?')
      EFVAR=0
      READ(UNIT5,28001)ANS
      IF(ANS.EQ.YESY)EFVAR=1
 2820 CONTINUE
      WRITE(UNIT6,28031)
28031 FORMAT(' DO YOU WANT TO INCLUDE THE INTERCEPT IN THE'
     * ' MODEL?')
      INTCEP=0
      READ(UNIT5,28033)ANS,KBUG
28033 FORMAT(A1,2X,I1)
      IF(ANS.NE.YESY) GO TO 28032
      INTCEP=1
      IF(MSOURC.LE.MSOMIX) GO TO 28032
      WRITE(UNIT6,28034) MSOMAX
28034 FORMAT(/' NUMBER OF SOURCES PLUS INTERCEPT EXCEEDS ',I2)
      GO TO 500
28032 CONTINUE
C  ENCODE TRANSFER ARRAYS
      MEL=MEL1(SIZ)
      MSOURC=MSORC1(SIZ)
      I=0
      DO 2830 KEL=1,MEL
      IEL=ELHOLD(KEL,SIZ)
      C(KEL)=UCNC(IEL,SIZ)
      V(KEL)=UUCNC(IEL,SIZ)
      IF(V(KEL).GT. 0.0)GO TO 2824
      IF(I.EQ.0)WRITE(UNIT6,2822)
 2822 FORMAT(' **ERROR**   SOME RECEPTOR CONCENTRATION STANDARD ERRORS'
     * ' ARE LESS THAN'/'  OR EQUAL TO ZERO.   WEIGHTED REGRESSION '
     * 'CANNOT BE DONE IN THIS CASE.')
      WRITE(UNIT6,2823)IEL,ELMENT(IEL),UCNC(IEL,SIZ),UUCNC(IEL,SIZ)
 2823 FORMAT(' ',I2,1X,A8,3X,'CONC=',F10.3,5X,'STD ERR=',F10.3)
      I=1
 2824 CONTINUE
      DO 2825 KSOURC=1,MSOURC
      JSOURC=SOHOLD(KSOURC,SIZ)
      F(KEL,KSOURC)=A(IEL,JSOURC,SIZ)
      SF(KEL,KSOURC)=UA(IEL,JSOURC,SIZ)
2825  CONTINUE
2830  CONTINUE
      DO 2832 JSOURC=1,35
      VIFELK(JSOURC)=0.0
      SELK(JSOURC)=0.0
      UELK(JSOURC)=0.0
 2832 CONTINUE
      IF(I.GT.0)GO TO 500
      TOTALA=UCMSS
```

TABLE A.1 CMB MAIN PROGRAM   (CONTINUED)

```
      IF(SIZ.EQ.1)TOTALA=UFMSS
      CALL CMBR(F,C,MEL,MSOURC,MELMAX,MSOMAX,SF,V,VK,TOTALA,SSET,
     * KINDEX,SAS,SAA,SR2,R2LS,VIF,
     * RIDGE,EFVAR,INTCEP,IERR,KBUG,CWT,
     * W,XP,YP,XMEAN,XPX,XPXK,XPY,SX,S,TM,AP,SOLD,IS,IA,ITM
     * )
      IFLAG(SIZ)=IERR
C  INITIALIZE ALL SOURCES TO ZERO
2840  DO 2845 JSOURC=1,NSOURC
      USORC(JSOURC,SIZ)=0.0
      UUSORC(JSOURC,SIZ)=0.0
 2845 CONTINUE
C  REPLACE SOURCES WITH CALCULATED VALUES
2850  CONTINUE
      SETLS=SSET(1)
      SET(SIZ)=SSET(2)
      DO 2855 KSOURC=1,MSOURC
      JSOURC=SOHOLD(KSOURC,SIZ)
      USORC(JSOURC,SIZ)=SAS(KSOURC,KINDEX)
      UUSORC(JSOURC,SIZ)=SAA(KSOURC,KINDEX)
      VIFELK(JSOURC)=VIF(KSOURC)
      SELK(JSOURC)=SAS(KSOURC,1)
      UELK(JSOURC)=SAA(KSOURC,1)
2855  CONTINUE
      IF(INTCEP.EQ.0)GO TO 2856
      I=MSOURC+1
      SAINT(SIZ)=SAS(I,KINDEX)
      USAINT(SIZ)=SAA(I,KINDEX)
      SAINTO=SAS(I,1)
      USAINO=SAA(I,1)
      GO TO 2857
 2856 SAINT(SIZ)=0.0
      SAINTO=0.0
      USAINT(SIZ)=0.0
      USAINO=0.0
C  GO TO CALCON
2857  IRTN=2
      GO TO 3800
2860  IRTN=1
C  PRINT ON SCREEN
C NO SOLUTION DISPLAYED FOR SINGULAR MATRIX
      IF(IERR.EQ.1)GO TO 500
      GO TO 3200
C
C
C
C
COMMAND  -PSOLN.   PRINT ALL RIDGE SOLUTIONS ON SCREEN
```

TABLE A.1 CMB MAIN PROGRAM   (CONTINUED)

```
C                                OR HARD COPY
C
42000 CONTINUE
      IF(RIDGE.EQ.0)GO TO 42060
      J=31*(2*MSOURC+1)
      I=MSOURC+1
      WRITE(UNIT6,42001) MSOURC,J
42001 FORMAT(' THERE ARE 31 SOLUTIONS WITH AN INTERCEPT'/
     * ' AND ',I2,' SOURCE COEFICIENTS AND STANDARD ERRORS'/
     * ' EACH FOR ',I4,' NUMBERS TOTAL.'/
     * ' THEY CAN PRINT TO YOUR TERMINAL OR TO HARD COPY.'/
     * ' ARE YOU SURE YOU WANT TO LOOK AT THESE NUMBERS?')
      READ(UNIT5,28001)ANS
      IF (ANS.NE.YESY) GO TO 500
      WRITE(UNIT6,42002)
42002 FORMAT(' DO YOU WANT THE SOLUTIONS PRINTED ON THE HARD COPY',
     * / ' (INSTEAD OF AT YOUR TERMINAL)?')
      READ(UNIT5,28001)ANS
      UNITX=UNIT6
      MANY=2
      IF(ANS.NE.YESY)GO TO 42004
      UNITX=UNIT11
      MANY=6
      GO TO 42005
42004 WRITE(UNIT6,42010)
42010 FORMAT(' CAN YOUR TERMINAL DISPLAY A 132 CHARACTER LINE?')
      READ(UNIT5,28001)ANS
      IF(ANS.EQ.YESY)MANY=6
42005 MORE=MANY+1
      IF(INTCEP.EQ.0)WRITE(UNIT6,42011)
42011 FORMAT(/' ZERO INTERCEPT IN MODEL'/)
      DO 42050 KEL=1,31,MORE
      IEL=KEL+MANY
      IF(IEL.GT.31)IEL=31
      WRITE(UNITX,42006)(VK(J),J=KEL,IEL)
      IF(INTCEP.GT.0)
     *WRITE(UNITX,42007)(SAS(I,J),SAA(I,J),J=KEL,IEL)
42006 FORMAT(//' RIDGE K',5X,7(F7.3,10X))
42007 FORMAT(' INTERCEPT',3X,  7(F7.3,'+-',F6.3,2X))
      DO 42040 KSOURC=1,MSOURC
      JSOURC=SOHOLD(KSOURC,SIZ)
      WRITE(UNITX,42008) SOUNAM(JSOURC),(SAS(KSOURC,J),
     *  SAA(KSOURC,J),J=KEL,IEL)
42008 FORMAT(' ',A8,4X,7(F7.3,'+-',F6.3,2X))
42040 CONTINUE
42050 CONTINUE
      IF (UNITX.EQ.UNIT11 ) WRITE(UNIT6,42051)
42051 FORMAT(' SOLUTIONS WRITTEN TO HARD COPY')
```

TABLE A.1 CMB MAIN PROGRAM   (CONTINUED)

```
      GO TO 500
42060 WRITE(UNIT6,42061)
42061 FORMAT(' THE RIDGE OPTION WAS NOT USED - ONLY 1 SOLUTION')
      GO TO 500
C
C
COMMAND   -PMATRIX        PRINT SOURCE SIGNATURE MATRIX, RECEPTOR
C                               RECEPTOR CONCENTRATIONS
C                               CODES FOR SOURCES AND SPECIES
C
43000 CONTINUE
C
      LOOP=0
      UNITX=UNIT11
      WRITE(UNIT6,43002)
43002 FORMAT(' MATRICES CAN GO TO HARD COPY'/
     * ' DO YOU WANT THEM DISPLAYED AT YOUR TERMINAL INSTEAD?')
      READ(UNIT5,28001) ANS
      IF(ANS.EQ.YESY)UNITX=UNIT6
43005 WRITE(UNIT6,43010)
43010 FORMAT(' WHAT DO YOU WANT TO SEE?'/
     * ' SOURCE SIGNATURE, RECEPTOR CONCENTRATIONS, OR CODES?')
      IF(LOOP.EQ.1)WRITE(UNIT6,43020)
43020 FORMAT(' OR ARE YOU DONE?')
      READ(UNIT5,28001,ERR=43005) ANS
      IF (ANS.EQ.QUOTD .OR. ANS.EQ.YESY .OR. ANS.EQ.IBLANK)
     * GO TO 500
      LOOP=1
      IF(ANS.EQ.QUOTR)GO TO 3700
      IF(ANS.EQ.QUOTS)GO TO 43039
      IF(ANS.EQ.QUOTC)GO TO 43800
      WRITE(UNIT6,43060)
43060 FORMAT(' INVALID REQUEST')
      GO TO 43005
43039 CONTINUE
      WRITE(UNIT6,43040)
43040 FORMAT(' WHAT SIZE FRACTION? (FINE OR COARSE)')
      READ(UNIT5,28001)CHK
      ISIZ=1
      IF(CHK.EQ.QUOTC) ISIZ=2
43310 FORMAT(' ',I2,1X,A8,5X,F8.4,2X,'+-',2X,F8.4)
C DISPLAY SOURCE SIGNATURE
43200 CONTINUE
      WRITE(UNIT6,43210) NSOURC,NEL
43210 FORMAT(' DO YOU WANT TO LOOK AT THE WHOLE MATRIX?'/
     * ' IT IS ',I2,' SOURCES BY ',I2,' SPECIES')
      READ(UNIT5,28001)ANS
      IF(ANS.NE.YESY) GO TO 43500
```

TABLE A.1 CMB MAIN PROGRAM (CONTINUED)

```
C DISPLAY WHOLE SOURCE SIGNATURE MATRIX
      IWIDE=1
      IF(UNITX.NE.UNIT6)GO TO 43213
      WRITE(UNIT6,43045)
43045 FORMAT(' CAN YOUR TERMINAL DISPLAY A 132 CHARACTER LINE?')
      READ(UNIT5,28001)ANS
      IF(ANS.NE.YESY)IWIDE=0
43213 MANY=5
      IF(IWIDE.EQ.1)MANY=12
      MORE=MANY+1
      DO 43240 KEL=1,NSOURC,MORE
      IEL=KEL+MANY
      IF(IEL.GT.NSOURC)IEL=NSOURC
      WRITE(UNITX,43218)(SOUNAM(I),I=KEL,IEL)
43218 FORMAT(' ',14X,13A9)
      DO 43230 J=1,NEL
      WRITE(UNITX,43220)J, ELMENT(J),(A(J,I,ISIZ),I=KEL,IEL)
      WRITE(UNITX,43221) (UA(J,I,ISIZ),I=KEL,IEL)
43220 FORMAT(/' ',I2,1X,A8,3X,13F9.4)
43221 FORMAT(' ',14X,13F9.4)
43230 CONTINUE
43240 CONTINUE
      GO TO 43005
C DISPLAY INDIVIDUAL SOURCE SIGNATURES
43500 CONTINUE
43502 WRITE(UNIT6,43510)
43510 FORMAT(' WHICH SOURCE DO YOU WANT?'/
     * ' GIVE SOURCE #')
      READ(UNIT5,2420,ERR=43502)I,SPACE
      IF(SPACE.EQ.IBLANK)I=I/10
      IF(I.LE.0)GO TO 43005
      WRITE(UNITX,43515) SOUNAM(I)
43515 FORMAT(' SOURCE: ',A8)
      DO 43520 J=1,NEL
      WRITE(UNITX,43310) J,ELMENT(J),A(J,I,ISIZ),UA(J,I,ISIZ)
C DISPLAY SOURCES AND SPECIES CODE LISTS
43520 CONTINUE
      GO TO 43500
43800 CONTINUE
      WRITE(UNITX,43810)
43810 FORMAT(/' SOURCE #',8X,'NAME',12X,'CODE')
      DO 43820 I=1,NSOURC
      WRITE(UNITX,43815) I,SOUNAM(I),SCODE(I)
43815 FORMAT(' ',3X,I2,10X,A8,10X,I2)
43820 CONTINUE
      WRITE(UNITX,43830)
43830 FORMAT(/' SPECIES #',7X,'NAME',12X,'CODE')
      DO 43840 I=1,NEL
```

TABLE A.1 CMB MAIN PROGRAM (CONTINUED)

```
      WRITE(UNITX,43815)I,ELMENT(I),PCODE(I)
43840 CONTINUE
      WRITE(UNITX,43850)
43850 FORMAT(/' USE SOURCE # AND SPECIES # FOR ALL YOUR '
     * 'RESPONSES'/ ' USE CODES ONLY WHEN CODING '
     * 'MATRICES FOR THE DATA BASE')
      GO TO 43005
C
C
C
C      -PINFO.  PRINT CURRENT STATUS ON SCREEN
3000  WRITE(UNIT6,3005)
3005  FORMAT('               ***CURRENT STATUS***')
      WRITE(UNIT6,3030)CMBID,SIZNAM(SIZ),UDUR,USTART,YBACK(IBACK)
3030  FORMAT(' CMB SITE: ',3A4,5X,'YEAR: ',A2,3X,'DATE: ',A4/
     * 1X,A8,'SIZE FRACTION'/
     *1X,'DURATION: ',I2,'  START HOUR: ',I2,/,
     *1X,'HAS BACKGROUND BEEN SUBTRACTED: ',A3)
      IF(IBACK.EQ.2)GO TO 3040
      WRITE(UNIT6,3035)BACKID,BDUR,BSTART
3035  FORMAT(1H ,'SUBTRACTED BACKGROUND CMB SITE: ',3A4,5X,
     * 'YEAR: ',A2,3X,'DATE: ',A4/
     *1X,'DURATION: ',I2,'  START HOUR: ',I2)
3040  WRITE(UNIT6,3045)
3045  FORMAT(1H ,'FITTING SPECIES')
      DO 3055 KEL=1,MEL
      IEL=ELHOLD(KEL,SIZ)
      WRITE(UNIT6,425)IEL,ELMENT(IEL)
3055  CONTINUE
      WRITE(UNIT6,3060)
3060  FORMAT(1H ,'FITTING SOURCES')
      DO 3080 KSOURC=1,MSOURC
      JSOURC=SOHOLD(KSOURC,SIZ)
      WRITE(UNIT6,425)JSOURC,SOUNAM(JSOURC)
3080  CONTINUE
      GO TO (500,2860,4120,4130,4132,4150,4250,4260,4270,4280),IRTN
C
C
C
C      -SIZE.   CHANGES SIZE FRACTION BETWEEN FINE AND COARSE
C
C
C
 3100 ISIZ=SIZ
      IF(ISIZ.EQ.1)SIZ=2
      IF(ISIZ.EQ.2)SIZ=1
      WRITE(UNIT6,3110)SIZNAM(SIZ)
 3110 FORMAT(' SIZE IS ',A8)
```

TABLE A.1 CMB MAIN PROGRAM   (CONTINUED)

```
      IRTN=1
      GO TO 500
C
C
C
C
C     -PDATA.  PRINTS CURRENT CMB RESULTS TO SCREEN
C
C
 3200 I=2-EFVAR
      WRITE(UNIT6,3205)CMBID,SIZNAM(SIZ),UDUR,USTART,YBACK(IBACK),
     * YBACK(I),SR2,VK(KINDEX),R2LS
 3205 FORMAT('0CMB SITE: ',3A4,5X,'YEAR: ',A2,3X,'DATE: ',A4,6X,
     * 'FRACTION: ',A6/ ' SAMPLE DURATION: ',I2,
     *  ' WITH START HOUR: ',I2,2X,'BACKGROUND: ',A3,
     * 2X,'EFF VAR: ',A3/
     * 1X,9('-'),'RIDGE REGRESSION',8('-'),4X,5('-'),
     * 'WEIGHTED LEAST SQUARES',5('-')/
     * 3X,'R-SQUARE:',F6.4,3X,'RIDGE K=',F5.3,12X,
     * 'R-SQUARE:',F6.4/
     * ' ---SOURCE',10('-'),'UG/M3',9('-'),4X,7('-'),'UG/M3',
     * 10('-'),'VIF',7('-'))
      WRITE(UNIT6,3208)SAINT(SIZ),USAINT(SIZ),SAINTO,USAINO
 3208  FORMAT(3X,'INTERCEPT',F10.3,'+-',F8.3,5X,F10.3,'+-',F8.3)
      X=SAINT(SIZ)
      XX=SAINTO
      DO 3240 JSOURC=1,NSOURC
      IF(UUSORC(JSOURC,SIZ).LE.0.)GO TO 3240
      WRITE(UNIT6,3230)JSOURC,SOUNAM(JSOURC),
     1USORC(JSOURC,SIZ),UUSORC(JSOURC,SIZ),SELK(JSOURC),UELK(JSOURC),
     * VIFELK(JSOURC)
3230   FORMAT(1H ,I2,1X,A8,F10.3,'+-',F8.3,
     * 5X,F10.3,'+-',F8.3,1X,F8.3)
      X=X+USORC(JSOURC,SIZ)
      XX=XX+SELK(JSOURC)
3240  CONTINUE
      WRITE(UNIT6,3245)X,SET(SIZ),XX,SETLS
3245  FORMAT(1H ,'TOTAL: ',4X,F10.3,'+-',F8.3,5X,F10.3,'+-',F8.3)
      WRITE(UNIT6,3279)
      WRITE(UNIT6,3280)UFMSS,UUFMSS,UCMSS,UUCMSS,UTMSS,UUTMSS
3279  FORMAT(1H ,'MEASURED CONCENTRATION FINE/COARSE/TOTAL:')
3280  FORMAT(1H ,2(F10.5,'+-',F8.3,'/'),F10.5,'+-',F8.3)
 3241 WRITE(UNIT6,3250)
 3250 FORMAT(1X,'PRESS RETURN TO CONTINUE OR ENTER C FOR NEXT ',
     * 'COMMAND')
3243   READ(UNIT5,28001,ERR=3248)ANS
       IF(ANS .EQ. QUOTC)GO TO 3275
       IF(ANS .EQ. IBLANK)GO TO 3244
```

```
C  OPTION TO "STOP" IN AUTOFIT
       IF(ANS .NE. QUOTS)GO TO 3248
 3246  IRTN=1
       KCNTRL=ICNTRL
       ICNTRL=4
       GO TO 500
3248   WRITE(UNIT6,3249)
3249   FORMAT(1X,'INPUT ERROR.')
       GO TO 3241
3244   WRITE(UNIT6,3247)
3247   FORMAT(1H ,25('-'),'MEAS',12('-'),'CALC',10('-'),'RATIO',10('-'))
CORRECT STD. ERR. FOR TOTAL AEROSOL
       UCLCN(1,SIZ)=SET(SIZ)
       DO 3270 IEL=1,NEL
       IF(UCNC(IEL,SIZ).LE.0.)RATIO=0.
       IF(UCNC(IEL,SIZ).LE.0.)URATIO=0.
       IF(UCNC(IEL,SIZ).LE.0)GO TO 3242
       RATIO=CLCN(IEL,SIZ)/UCNC(IEL,SIZ)
       URATIO=((UCLCN(IEL,SIZ)/UCNC(IEL,SIZ))**2+(UUCNC(IEL,SIZ)
      1*CLCN(IEL,SIZ)/UCNC(IEL,SIZ)**2)**2)**.5
3242   IF(UCNC(IEL,SIZ).GE.UUCNC(IEL,SIZ))
      1WRITE(UNIT6,3260)IEL,ELMENT(IEL),ELFT(IEL,SIZ),MFLAG(IEL,SIZ),
      1UCNC(IEL,SIZ),
      1UUCNC(IEL,SIZ),CLCN(IEL,SIZ),UCLCN(IEL,SIZ),RATIO,URATIO,
      1ELMENT(IEL)
       IF(UCNC(IEL,SIZ).LT.UUCNC(IEL,SIZ))
      1WRITE(UNIT6,3265)IEL,ELMENT(IEL),ELFT(IEL,SIZ),MFLAG(IEL,SIZ),
      1UUCNC(IEL,SIZ),CLCN(IEL,SIZ),UCLCN(IEL,SIZ),
      1RATIO,URATIO,ELMENT(IEL)
3260   FORMAT(1H ,I2,1X,A8,2X,A1,2X,A1,1X,F7.3,'+-',F6.3,1X,
      11X,F7.3,'+-',F6.3,1X,F5.2,'+-',F5.2,2X,A3)
3265   FORMAT(1H ,I2,1X,A8,2X,A1,2X,A1,1X,7X,'< ',F6.3,1X,
      11X,F7.3,'+-',F6.3,1X,F5.2,'+-',F5.2,2X,A3)
3270   CONTINUE
CHANCE TO HOLD FOR CRT
       IF(ICNTRL.NE.2 .AND. ICNTRL.NE.0)GO TO 3276
       IRTN=5
       IF(SIZ.EQ.2 .AND. ICNTRL.EQ.0)GO TO 3276
       READ(UNIT5,28001)ANS
       IF(ANS.EQ.QUOTS)GO TO 3246
       GO TO 3276
 3275  IF(ICNTRL.EQ.2 .OR. ICNTRL.EQ.0)IRTN=5
 3276  GO TO (500,2860,4120,4130,4132,4150,4250,4260,4270,4280),IRTN
C
C
C
C
C        -WRITE.  WRITES DATA TO HARDCOPY
```

TABLE A.1 CMB MAIN PROGRAM   (CONTINUED)

```
3400  JRTN=5
C
3402  UNIT=UNIT11
      ISIZ=SIZ
      IPF=IFLAG(ISIZ)
3413  WRITE(UNIT,3415)CMBID,(FLAG(I,IPF+1),I=1,8),SIZNAM(ISIZ)
3415  FORMAT(' ',/,1X,'RESULTS FOR CMB SITE: ',3A4,5X,
     * 'YEAR: ',A2,3X,'DATE: ',A4,4X,8A4,
     *1X,/,' ',A6,' PARTICULATE FRACTION')
3417  FORMAT(1X,' ')
      WRITE(UNIT,3430)UDUR,USTART
3430  FORMAT(
     *1X,'SAMPLING DURATION: ',I2,' HRS. WITH START HOUR: ',I2)
      WRITE(UNIT,3440)YBACK(IBACK)
3440  FORMAT(1H ,'BACKGROUND SITE SUBTRACTED: ',A3)
      IF(IBACK.EQ.2)GO TO 3460
C WRITE BACKG INFO
      WRITE(UNIT,3450)BACKID
3450  FORMAT(' BACKGROUND CMB SITE: ',3A4,5X,
     *  'YEAR: ',A2,3X,'DATE: ',A4)
      WRITE(UNIT,3430)BDUR,BSTART
3460  IF(ISIZ.NE.3)GO TO 3466
      WRITE(UNIT,3468)
3468  FORMAT(' RESULTS DERIVED FROM FINE AND COARSE FITTINGS')
      SAINT(3)=SAINT(1)+SAINT(2)
      USAINT(3)=SQRT(USAINT(1)**2+USAINT(2)**2)
      WRITE(UNIT,3477)SAINT(3),USAINT(3)
      GO TO 3478
 3466 IF(INTCEP.EQ.0)WRITE(UNIT,3469)
 3469 FORMAT(' INTERCEPT SET TO ZERO')
      IF(RIDGE.EQ.0)WRITE(UNIT,3470)
 3470 FORMAT(' RIDGE OPTION NOT USED')
      IF(EFVAR.GT.0)WRITE(UNIT,3471)
 3471 FORMAT(' EFFECTIVE VARIANCE METHOD')
C  WRITE HEADER
3474  WRITE(UNIT,3476)VK(KINDEX),SR2,R2LS,SAINT(ISIZ),USAINT(ISIZ),
     * SAINTO,USAINO
3476  FORMAT(25X,'RIDGE REGRESSION',25X,'LEAST SQUARES'/
     * 25X,'K=',F5.3,5X,'R-SQUARE: ',F6.4,13X,'K=0.0',5X,
     * 'R-SQUARE: ',F6.4/' ',120('-')/
     *   1X,'CODE',2X,'SOURCE',13X,'UG/M3',15X,'%',
     *  22X,'UG/M3',13X,'VIF'/' ',120('-')
     * /5X,'INTERCEPT',3X,F8.3,'+-',F8.3,26X,F8.3,'+-',F8.3)
 3477 FORMAT(/' ',120('-')/1X,'CODE',2X,'SOURCE',13X,'UG/M3',
     * 15X,'%'/' ',120('-')/5X,'INTERCEPT',3X,F8.3,'+-',F8.3)
C  WRITE SOURCES
 3478 TX=SAINT(ISIZ)
      XX=SAINTO
```

TABLE A.1 CMB MAIN PROGRAM   (CONTINUED)

```
      ISCTR=0
      DO 3490  JSOURC=1,NSOURC
      IF(UUSORC(JSOURC,1).LE.0..AND.UUSORC(JSOURC,2)
     1.LE.0.)GO TO 3490
      IF(ISIZ.EQ.1.AND.UUSORC(JSOURC,1).LE.0.)GO TO 3490
      IF(ISIZ.EQ.1)X=UFMSS
      IF(ISIZ.EQ.1)UX=UUFMSS
      IF(ISIZ.EQ.2)X=UCMSS
      IF(ISIZ.EQ.2)UX=UUCMSS
      IF(ISIZ.EQ.3)X=UTMSS
      IF(ISIZ.EQ.3)UX=UUTMSS
C  GET TOTAL SOURCE
      IF(ISIZ.NE.3)GO TO 3480
      USORC(JSOURC,3)=USORC(JSOURC,1)+USORC(JSOURC,2)
      UUSORC(JSOURC,3)=((UUSORC(JSOURC,1))**2+UUSORC(JSOURC,2)**2)**.5
3480  CALL PERC(PCNT,UPCNT,USORC(JSOURC,ISIZ),UUSORC(JSOURC,ISIZ),X,UX)
      IF(UX.LE.0.)GO TO 3490
      IF(ISIZ.LT.3)WRITE(UNIT,3485)JSOURC,SOUNAM(JSOURC),
     1USORC(JSOURC,ISIZ),UUSORC(JSOURC,ISIZ),PCNT,UPCNT,
     *  SELK(JSOURC),UELK(JSOURC),VIFELK(JSOURC)
      IF(ISIZ.EQ.3) WRITE(UNIT,3485) JSOURC,SOUNAM(JSOURC),
     * USORC(JSOURC,ISIZ),UUSORC(JSOURC,ISIZ),PCNT,UPCNT
3485  FORMAT(1X,I2,3X,A8,1X,F10.3,'+-',F8.3,2X,F7.3,'+-',F6.3,
     * 7X,F10.3,'+-',F8.3,2X,F8.3)
      TX=TX+USORC(JSOURC,ISIZ)
      XX=XX+SELK(JSOURC)
C INCREMENT SOURCE COUNTER
      ISCTR=ISCTR+1
C IF TOTAL FRACTION, HOLD SOURCE CODES FOR SUMMARY
      IF (ISIZ.EQ.3)ISHOLD(ISCTR)=JSOURC
3490  CONTINUE
      IF(ISIZ.EQ.3)SET(3)=SQRT(SET(1)**2+SET(2)**2)
      WRITE(UNIT,3499)
      CALL PERC(PCNT,UPCNT,TX,SET(ISIZ),X,UX)
      IF(ISIZ.LT.3)WRITE(UNIT,3491)TX,SET(ISIZ),PCNT,UPCNT,XX,SETLS
      IF(ISIZ.EQ.3)WRITE(UNIT,3491)TX,SET(ISIZ),PCNT,UPCNT
3491  FORMAT(6X,'TOTAL:',3X,F10.3,'+-',F8.3,2X,F7.3,'+-',F6.3,7X,F10.3
     * '+-',F8.3)
      WRITE(UNIT,3417)
C  WRITE ELEMENTS
C  WRITE HEADER
      WRITE(UNIT,3495)SIZNAM(ISIZ)
3495  FORMAT(1X,'SPECIES    FIT',2X,'MISS',9X,A6,1X,
     *'SUSPENDED PARTICULATE')
      WRITE(UNIT,3497)
3497  FORMAT(' CODE        FLG',2X,'FLG',3X,'MEAS. UG/M3',8X,
     *1X,'PERCENT',7X,'CALC. UG/M3',7X,'RATIO')
      WRITE(UNIT,3499)
```

```
3499  FORMAT(1X,120('-'))
3500  FORMAT(2X,I2,2X,A6,2X,A1,2X,A1,2X,2(F7.3,'+-',F6.3,1X),1X,
     11X,F7.3,'+-',F6.3,1X,F6.3,'+-',F6.3,2X,A8)
3505  FORMAT(2X,I2,2X,A6,2X,A1,2X,A1,2X,2(7X,'< ',F6.3,1X),
     12X,F7.3,'+-',F6.3,1X,F6.3,'+-',F6.3,2X,A8)
CORRECT STD. ERR. FOR TOTAL
      UCLCN(1,ISIZ)=SET(ISIZ)
      DO 3530 IEL=1,NEL
      IF(ISIZ.EQ.3)CLCN(IEL,ISIZ)=CLCN(IEL,1)+CLCN(IEL,2)
      IF(ISIZ.EQ.3)UCLCN(IEL,ISIZ)=
     *SQRT((UCLCN(IEL,1))**2+(UCLCN(IEL,2))**2)
3525  IF(UCNC(IEL,ISIZ).EQ.0.)RATIO=0.
      IF(UCNC(IEL,ISIZ).LE.0.)URATIO=0.
      IF(UCNC(IEL,ISIZ).LE.0.)GO TO 3526
      RATIO=CLCN(IEL,ISIZ)/UCNC(IEL,ISIZ)
      URATIO=SQRT((UCLCN(IEL,ISIZ)/UCNC(IEL,ISIZ))**2+
     *(UCLCN(IEL,ISIZ)*CLCN(IEL,ISIZ)/UCNC(IEL,ISIZ)**2)**2)
3526  CALL PERC(PCNT,UPCNT,UCNC(IEL,ISIZ),UUCNC(IEL,ISIZ),X,UX)
      IF(UCNC(IEL,ISIZ).GE.UUCNC(IEL,ISIZ))WRITE(UNIT,3500)IEL,
     *ELMENT(IEL),ELFT(IEL,SIZ),MFLAG(IEL,ISIZ),UCNC(IEL,ISIZ),UUCNC
     *(IEL,ISIZ),PCNT,UPCNT,CLCN(IEL,ISIZ),UCLCN(IEL,ISIZ),RATIO,URATIO,
     *ELMENT(IEL)
      IF(UCNC(IEL,ISIZ).LT.UUCNC(IEL,ISIZ))WRITE(UNIT,3505)IEL,
     *ELMENT(IEL),ELFT(IEL,SIZ),MFLAG(IEL,ISIZ),UCNC(IEL,ISIZ),UPCNT,
     *CLCN(IEL,ISIZ),UCLCN(IEL,ISIZ),RATIO,URATIO,ELMENT(IEL)
3530  CONTINUE
      WRITE(UNIT,3499)
C WRITE MASSES
      WRITE(UNIT,3540)UFMSS,UUFMSS,UCMSS,UUCMSS,UTMSS,UUTMSS
3540  FORMAT(' MEASURED AMBIENT MASS (UG/M3):  FINE: ',
     *1X,F5.1,'+-',F4.1,'   COARSE: ',F5.1,'+-',F4.1,'   TOTAL: ',
     *1X,F5.1,'+-',F4.1)
      WRITE(UNIT,3543)
 3543 FORMAT(////'1')
 3545 WRITE(UNIT6,3546)
 3546 FORMAT(' WRITTEN')
      IF(ISIZ.NE.1)GO TO 3549
      DO 3547 IEL=1,5
 3547 OLDID(IEL)=CMBID(IEL)
 3548 GO TO (500,2860,4120,4130,4132,4150,4250,4260,
     *4270,4280),IRTN
 3549 IF(ISIZ.EQ.3)GO TO 3600
 3550 DO 3552 IEL=1,5
      IF(OLDID(IEL).NE.CMBID(IEL))GO TO 3548
 3552 CONTINUE
      ISIZ=3
      IPF=0
      IF(IFLAG(1).EQ.2.OR.IFLAG(2).EQ.2)IPF=2
```

TABLE A.1 CMB MAIN PROGRAM   (CONTINUED)

```
      IF(IFLAG(1).EQ.1.OR.IFLAG(2).EQ.1)IPF=1
      GO TO 3413
C  WRITE SUMMARY FILE
 3600 CONTINUE
      UNIT=UNIT9
C WRITE HEADERS
      WRITE(UNIT,3605)
 3605 FORMAT(' '//39X,'*** CMB SOURCE CONTRIBUTION SUMMARY ***'/' ')
 3613 WRITE(UNIT,3615)CMBID
 3615  FORMAT(' ',/,36X,'RESULTS FOR CMB SITE: ',3A4,5X,
     *  'YEAR: ',A2,3X,'DATE: ',A4)
 3617 FORMAT(1X,' ')
      WRITE(UNIT,3630)UDUR,USTART
 3630 FORMAT(
     *1X,30X,'SAMPLING DURATION: ',I2,' HRS. WITH START HOUR: ',I2)
      WRITE(UNIT,3640)YBACK(IBACK)
 3640 FORMAT(30X,'BACKGROUND SITE SUBTRACTED: ',A3)
      IF(IBACK.EQ.2)GO TO 3652
C WRITE BACKG INFO
      WRITE(UNIT,3650)BACKID
 3650 FORMAT(30X,'BACKGROUND CMB SITE: ',3A4,5X,'YEAR: ',A2,3X,
     *  'DATE: ',A4)
      WRITE(UNIT,3630)BDUR,BSTART
 3652 CONTINUE
      IS1=IFLAG(1)+1
      IS2=IFLAG(2)+1
      WRITE(UNIT,3654)ISTAR(IS1),ISTAR(IS2)
 3654 FORMAT(/,1X,' SOURCE ',18X,'FINE',A4,26X,'COARSE',A4,25X,'TOTAL'/
     *1X,117('-')/3(16X,'UG/M3',15X,'%'))
C CALCULATE PERCENTS AND WRITE CONTRIBUTIONS
      FX=SAINT(1)
      CX=SAINT(2)
      TX=SAINT(3)
      WRITE(UNIT,3657)SAINT(1),USAINT(1),SAINT(2),USAINT(2),SAINT(3),
     *   USAINT(3)
  3657 FORMAT(' INTERCEPT',3(1X,F7.3,' +-',F7.3,18X))
      DO 3660 I=1,ISCTR
      J=ISHOLD(I)
      CALL PERC(FPCNT,UFPCNT,USORC(J,1),UUSORC(J,1),UFMSS,UUFMSS)
      CALL PERC(CPCNT,UCPCNT,USORC(J,2),UUSORC(J,2),UCMSS,UUCMSS)
      CALL PERC(TPCNT,UTPCNT,USORC(J,3),UUSORC(J,3),UTMSS,UUTMSS)
      WRITE(UNIT,3658)SOUNAM(J),USORC(J,1),UUSORC(J,1),FPCNT,UFPCNT,
     *USORC(J,2),UUSORC(J,2),CPCNT,UCPCNT,USORC(J,3),UUSORC(J,3),TPCNT,
     *UTPCNT
 3658 FORMAT(1X,A8,1X,6(1X,F7.3,' +-',F7.3))
C WRITE FILE FOR PCOMP COMMAND TO READ
      WRITE(UNIT10,3659)CMBID,J,SOUNAM(J),USORC(J,1),UUSORC(J,1),
     *  USORC(J,2),UUSORC(J,2),USORC(J,3),UUSORC(J,3)
```

TABLE A.1 CMB MAIN PROGRAM (CONTINUED)

```
 3659 FORMAT(3A4,A2,A4,1X,I2,1X,A8,2X,6F8.3)
C INCREMENT SUMS
      FX=FX+USORC(J,1)
      CX=CX+USORC(J,2)
      TX=TX+USORC(J,3)
3660  CONTINUE
C CALCULATE AND WRITE SUMS
      CALL PERC(FPCNT,UFPCNT,FX,SET(1),UFMSS,UUFMSS)
      CALL PERC(CPCNT,UCPCNT,CX,SET(2),UCMSS,UUCMSS)
      CALL PERC(TPCNT,UTPCNT,TX,SET(3),UTMSS,UUTMSS)
      WRITE(UNIT,3664)FX,SET(1),FPCNT,UFPCNT,CX,SET(2),CPCNT,UCPCNT,
     *TX,SET(3),TPCNT,UPCNT,UFMSS,UUFMSS,UCMSS,UUCMSS,UTMSS,UUTMSS
3664  FORMAT(1X,117('-')/,1X,'CALC.MASS',6(1X,F7.3,' +-',F7.3)/
     *1X,'MEAS.MASS',1X,3(F7.3,' +-',F7.3,19X)///)
      IF(IFLAG(1).EQ.1.OR.IFLAG(2).EQ.1)WRITE(UNIT,3671)(FLAG(I,2),I=1,8
     *)
      IF(IFLAG(1).EQ.2.OR.IFLAG(2).EQ.2)WRITE(UNIT,3672)(FLAG(I,3),I=1,8
     *)
3671  FORMAT(//,'  *NOTE: ',8A4)
3672  FORMAT(//,' **NOTE: ',8A4)
C WRITE MAGSTO FILE
C CALCULATE INDIVIDUAL ELEMENTAL CONTRIBUTIONS FOR EACH SOURCE
 3676 DO 3680 I=1,ISCTR
      J=ISHOLD(I)
C WRITE MASS CONTRIBUTION
      IX=01
      DO 3680 IEL=1,NEL
      DO 3677 ISIZ=1,2
      IF(A(IEL,J,ISIZ).LE.0.0E-09)SEL(ISIZ)=0.0
      IF(A(IEL,J,ISIZ).LE.0.0E-09)USEL(ISIZ)=0.0
      IF(A(IEL,J,ISIZ).LE.0.0E-09)GO TO 3677
      SEL(ISIZ)=A(IEL,J,ISIZ)*USORC(J,ISIZ)
      USEL(ISIZ)=SQRT(SEL(ISIZ)**2*((UA(IEL,J,ISIZ)/A(IEL,J,ISIZ))
     ***2+(UUSORC(J,ISIZ)/USORC(J,ISIZ))**2)
     * + (UA(IEL,J,ISIZ)*UUSORC(J,ISIZ))**2)
3677  CONTINUE
      IF(SEL(1).EQ.0.0.AND.SEL(2).EQ.0.0)GO TO 3680
      WRITE(UNIT12,3678)CMBID,UDUR,USTART,SCODE(J),PCODE(IEL)
     *,SEL(1),USEL(1),SEL(2),USEL(2)
3678  FORMAT('40',1X,3A4,1X,A2,A4,1X,I2,1X,I2,1X,I2,1X,
     *I2,2X,F9.4,2X,F9.4,2X,F9.4,2X,F9.4)
3680  CONTINUE
3995  GO TO(500,2860,4120,4130,4132,4150,4250,4260,4270,4280),IRTN
C
C
C
C
C
```

```
C
C
C
C      PART OF COMMAND PMATRIX
C         PRINTS CURRENT FINE AND COARSE MEASURED CONCENTRATIONS
 3700 WRITE(UNITX,3710)CMBID
 3710 FORMAT(1H ,'CURRENT MEASURED UG/M3 CONCENTRATIONS FOR'/' SITE:',
     * 3A4,5X,'YEAR: ',A2,2X,'DATE: ',A4,
     */1X,71('-'),/,1H ,'SPECIES',14X,'FINE',13X,'COARSE',13X,'TOTAL',
     */1X,71('-')//)
      DO 3730 I=1,NEL
      WRITE(UNITX,3720)I,ELMENT(I),UCNC(I,1),UUCNC(I,1),UCNC(I,2),
     *UUCNC(I,2),UCNC(I,3),UUCNC(I,3)
 3720    FORMAT(1H ,I2,1X,A8,1X,F8.3,'+-',F8.3,2(1X,F8.3,'+-',F8.3))
 3730 CONTINUE
      GO TO 43005
C
C
C
C
C
C      -CALCON.  CALCULATE CONCENTRATIONS.
 3800 DO 3850 IEL=1,NEL
      CLCN(IEL,SIZ)=SAINT(SIZ)
      UCLCN(IEL,SIZ)=0.0
      KSOURC=NSOURC
      DO 3840 JSOURC=1,KSOURC
      IF(UUSORC(JSOURC,SIZ).LE.0.)GO TO 3840
      CLCN(IEL,SIZ)=CLCN(IEL,SIZ)+A(IEL,JSOURC,SIZ)*USORC(JSOURC,SIZ)
      UCLCN(IEL,SIZ)=(UCLCN(IEL,SIZ)**2+(UA(IEL,JSOURC,SIZ)*USORC
     1(JSOURC,SIZ))**2)**.5
 3840 CONTINUE
 3850 CONTINUE
      GO TO (500,2860,4120,4130,4132,4150,4250,4260,4270,4280),IRTN
C
C
C
C
C        -RESUM. GO BACK INTO AUTOFIT
 4000 ICNTRL=KCNTRL
      GO TO 4132
C
C
C
C
C         -AUTOFIT.  STEPS THROUGH COMMAND SEQUENCE FOR A GIVEN SAMPLE
  4099 NOSKIP=0
 4100 CONTINUE
```

TABLE A.1 CMB MAIN PROGRAM   (CONTINUED)

```
C IF END OF AUTOFIT DATA, WRITE TO SCREEN AND GO TO COMMAND
      IF(ICNTRL.NE.0)GO TO 4106
      WRITE(UNIT6,4105)
4105  FORMAT(1H ,'AUTOFIT SEQUENCING FINISHED')
      ICNTRL=4
      IRTN=1
      GO TO 500
 4106 CONTINUE
C IF FIRST SAMPLE GO TO SELECT
      IRTN=3
      IF(ICNTRL.NE.2)GO TO 4210
C RETRIEVE NEXT CMBID FROM PREVIOUS DATA SEARCH
      DO 4110 I=1,5
 4110 CMBID(I)=SAVE(I)
C CALL UP DATA
4120  ICNTRL=1
      WRITE(UNIT6,4122)CMBID
4122  FORMAT(1H ,'DATA SEARCH BEGUN FOR',/6X,'SITE: ',3A4,5X,
     * 'YEAR: ',A2,2X,'DATE: ',A4/)
      CALL FETCH(QUOTA,CMBID,UDUR,USTART,UCNC,
     *UUCNC,UFMSS,UUFMSS,UCMSS,UUCMSS,UTMSS,UUTMSS,MFLAG,
     *SAVE,ICNTRL,TYPE,UNIT6,UNIT12,UNIT13)
      IF(ICNTRL.EQ.9)IRTN=1
      IF(ICNTRL.EQ.9)GO TO 500
4123  SIZ=1
 4124 CONTINUE
C PERFORM CEB
4130  IRTN=5
      GO TO 2801
 4132 NOSKIP=1
C RETURN FROM RESUM- WRITE DATA, GO TO NEXT SIZE
4135  IRTN=6
      GO TO 3400
4150  CONTINUE
CHECK IF DONE BOTH SIZES & RECYCLE AUTOFIT
      IF(SIZ.EQ.2)GO TO 4100
       SIZ=2
      GO TO 4124
C
C
C
C      -SELECT.  ALLOWS DATA SET SELECTION
C
4200  CONTINUE
      IRTN=7
4210  WRITE(UNIT6,4215)
4215  FORMAT(' ENTER DESIRED CMB SITE CODE: XXXXXXXXXXX')
      READ(UNIT5,4218,ERR=4210)SITE
```

TABLE A.1 CMB MAIN PROGRAM (CONTINUED)

```
      WRITE(UNIT6,4216)
      READ(UNIT5,4217) YEAR
      WRITE(UNIT6,4219)
      READ(UNIT5,4220) DATE
 4216 FORMAT(' ENTER YEAR: YY')
 4217 FORMAT(A2)
 4219 FORMAT(' ENTER DATE: MMDD')
 4220 FORMAT(A4)
4218  FORMAT(3A4)
      GO TO (500,2860,4120,4130,4132,4150,4250,4260,4270,4280),IRTN
4250  IRTN=8
C
4254  WRITE(UNIT6,4255)
4255  FORMAT(' INPUT DESIRED SIZE FRACTION:(FINE OR COARSE)')
      READ(UNIT5,28001,ERR=4254)ANS
      SIZ=1
      IF(ANS.EQ.QUOTC) SIZ=2
      ICNTRL=4
      WRITE(UNIT6,4122)CMBID
      CALL FETCH(QUOTS,CMBID,UDUR,USTART,UCNC,
     *UUCNC,UFMSS,UUFMSS,UCMSS,UUCMSS,UTMSS,UUTMSS,MFLAG,
     *DUM,ICNTRL,TYPE,UNIT6,UNIT12,UNIT13)
      IBACK=2
      IF (ICNTRL.EQ.9)IRTN=1
      IF(ICNTRL.EQ.9)GO TO 500
C DO CMB
4260  IRTN=9
      GO TO 2800
4270  CONTINUE
4280  CONTINUE
C
C
C
C
C       -INITIAL.  INITIALIZE FITTING SOURCES AND ELEMENTS
4400  WRITE(UNIT6,3110)SIZNAM(SIZ)
4401  DO 4410 IEL=1,NEL
      ELFT(IEL,SIZ)=IBLANK
4410  ELHOLD(IEL,SIZ)=0
      DO 4420 JSOURC=1,NSOURC
      SOUFT(JSOURC,SIZ)=IBLANK
4420  SOHOLD(JSOURC,SIZ)=0
4430  MEL=IMEL
      MEL1(SIZ)=IMEL
      MSOURC=IMSO
      MSORC1(SIZ)=IMSO
4440  DO 4450 KEL=1,MEL
      IEL=INITEL(KEL)
```

TABLE A.1 CMB MAIN PROGRAM   (CONTINUED)

```
      ELFT(IEL,SIZ)=STAR
      ELHOLD(KEL,SIZ)=IEL
 4450 CONTINUE
      DO 4460 KSOURC=1,MSOURC
      JSOURC=INITSO(KSOURC)
      SOUFT(JSOURC,SIZ)=STAR
      SOHOLD(KSOURC,SIZ)=JSOURC
 4460 CONTINUE
      IF(IRTN.EQ.0)GO TO 444
      GO TO (500,2860,4120,4130,4132,4150,4250,4260,4270,4280),IRTN
C
C
C
C
C
C      -BACKOUT. SELECTS AND SUBTRACTS BACKGROUND
 4600 CONTINUE
      IF(IBACK.NE.2)GO TO 4670
 4602 WRITE(UNIT6,4605)
 4605 FORMAT(' ENTER BACKGROUND CMB SITE CODE: XXXXXXXXXXXX')
      READ(UNIT5,4607,ERR=4602)BSITE
 4607 FORMAT(3A4)
      WRITE(UNIT6,4216)
      READ(UNIT5,4217) BYEAR
      WRITE(UNIT6,4219)
      READ(UNIT5,4220) BDATE
      ICNTRL=7
 4610 CALL FETCH(QUOTB,BACKID,BDUR,BSTART,BCNC,
     *UBCNC,BFMSS,UBFMSS,BCMSS,UBCMSS,BTMSS,UBTMSS,MFLAGB,
     *DUM,ICNTRL,TYPE,UNIT6,UNIT12,UNIT13)
      IF(ICNTRL.EQ.9)IRTN=1
      IF(ICNTRL.EQ.9)GO TO 500
      DO 4650 I=1,3
      DO 4650 IEL=1,NEL
      UCNC(IEL,I)=UCNC(IEL,I)-BCNC(IEL,I)
      UUCNC(IEL,I)=((UUCNC(IEL,I)**2)+UBCNC(IEL,I)**2)**.5
 4650 CONTINUE
      UFMSS=UFMSS-BFMSS
      UUFMSS=(UUFMSS**2+UBFMSS**2)**.5
      UCMSS=UCMSS-BCMSS
      UUCMSS=(UUCMSS**2+UBCMSS**2)**.5
      UTMSS=UTMSS-BTMSS
      UUTMSS=(UUTMSS**2+UBTMSS**2)**.5
      WRITE(UNIT6,4655)
 4655 FORMAT(' BACKOUT COMPLETE')
      GO TO 4680
 4670 WRITE(UNIT6,4675)
 4675 FORMAT(' CURRENT DATA ALREADY HAS BACKGROUND SUBTRACTED')
```

TABLE A.1 CMB MAIN PROGRAM (CONTINUED)

```
 4680 IBACK=1
      GO TO (500,2860,4120,4130,4132,4150,4250,4260,4270,4280),IRTN
C
C
C
C      -BACKIN. ELIMINATES CURRENT BACKGROUND SUBTRACTION
4700  CONTINUE
      IF(IBACK.NE.1)GO TO 4770
      DO 4750 I=1,3
      DO 4750 IEL=1,NEL
      UCNC(IEL,I)=UCNC(IEL,I)+BCNC(IEL,I)
      UUCNC(IEL,I)=((UUCNC(IEL,I)**2)-UBCNC(IEL,I)**2)**.5
4750  CONTINUE
      UFMSS=UFMSS+BFMSS
      UUFMSS=(UUFMSS**2-UBFMSS**2)**.5
      UCMSS=UCMSS+BCMSS
      UUCMSS=(UUCMSS**2-UBCMSS**2)**.5
      UTMSS=UTMSS+BTMSS
      UUTMSS=(UUTMSS**2-UBTMSS**2)**.5
      WRITE(UNIT6,4755)
 4755 FORMAT(' BACKIN COMPLETE')
      GO TO 4780
4770  WRITE(UNIT6,4775)
4775  FORMAT(1H ,'CURRENT CMB DATA DOES NOT HAVE BACKGROUND SUBTRACTED'
4780  IBACK=2
      GO TO (500,2860,4120,4130,4132,4150,4250,4260,4270,4280),IRTN
C
C
C
C
C - PCOMP
C
C
COMPUTE MEAN AND STANDARD DEVIATION OF SERIES
52000 UNIT=UNIT11
      WRITE(UNIT6,52001)
52001 FORMAT(' OUTPUT WILL GO TO HARDCOPY.'/
     *  ' DO YOU WANT IT DISPLAYED AT YOUR TERMINAL INSTEAD?')
      READ(UNIT5,28001)ANS
      IF(ANS.EQ.YESY)UNIT=UNIT6
      REWIND UNIT10
      DO 52005 I=1,MELMAX
      DO 52005 J=1,MSOMAX
      F(I,J)=0.0
      XP(I,J)=0.0
52005 SF(I,J)=0.0
      K=0
      M=0
```

TABLE A.1 CMB MAIN PROGRAM (CONTINUED)

```
52010 READ(UNIT10,52011,END=53000)TEMPID,J,FINE,COARSE,TOTAL
52011 FORMAT(3A4,3A2,1X,I2,11X,F8.3,8X,F8.3,8X,F8.3)
      DO 52020 I=1,6
      IF(TEMPID(I).NE.LASTID(I) .OR. K.EQ.0)GO TO 52030
52020 CONTINUE
      GO TO 52040
52030 K=K+1
      IF(K.GT.16)GO TO 53000
      DO 52032 I=1,6
      LASTID(I)=TEMPID(I)
      PNAM(K,I)=TEMPID(I)
52032 CONTINUE
52040 IF(M.GT.0)GO TO 52050
      ITM(1)=J
      M=1
      IEL=1
      GO TO 52060
52050 DO 52052 I=1,M
      IF(J.EQ.ITM(I)) GO TO 52055
52052 CONTINUE
      IF(M.GE.21)GO TO 52010
      M=M+1
      ITM(M)=J
      IEL=M
      GO TO 52060
52055 IEL=I
52060 F(IEL,K)=FINE
      XP(IEL,K)=COARSE
      SF(IEL,K)=TOTAL
      GO TO 52010
53000 DO 53090 I=1,M
      WRITE(UNIT,53970)
53970 FORMAT(/40X,'FINE',9X,'COARSE',7X,'TOTAL',/' ',3X,
     * 'CMB SITE',7X,'DATE',4X,'SOURCE',6X,'(UG/M3)',6X,
     * '(UG/M3)',6X,'(UG/M3)')
      X=0
      UX=0
      TX=0
      UTX=0
      PCNT=0
      UPCNT=0
      WRITE(UNIT,53972)
53972 FORMAT(4X,8('-'),7X,4('-'),4X,6('-'),6X,7('-'),6X,7('-'),
     * 6X,7('-')/)
      INDX=ITM(I)
      TEMPN=SOUNAM(INDX)
      DO 53080 J=1,K
      WRITE(UNIT,53978) (PNAM(J,IEL),IEL=1,6),TEMPN,F(I,J),XP(I,J),
```

TABLE A.1 CMB MAIN PROGRAM (CONTINUED)

```
     *  SF(I,J)
53978 FORMAT(2X,3A4,3X,A2,'/',A2,'/',A2,2X,A8,
     * 2X,F7.2,7X,F7.2,6X,F7.2)
      X=X+F(I,J)
      TX=TX+XP(I,J)
      PCNT=PCNT+SF(I,J)
      IF(K.LE.1)GO TO 53080
      UX=UX+F(I,J)**2
      UTX=UTX+XP(I,J)**2
      UPCNT=UPCNT+SF(I,J)**2
53080 CONTINUE
      WRITE(UNIT,53988)
53988 FORMAT(/39X,7('-'),6X,7('-'),6X,7('-'))
      IF(K.LE.1)GO TO 53989
      UX=SQRT((UX-X/K*X)/(K-1.))
      UTX=SQRT((UTX-TX/K*TX)/(K-1.))
      UPCNT=SQRT((UPCNT-PCNT/K*PCNT)/(K-1.))
      X=X/K
      TX=TX/K
      PCNT=PCNT/K
53989 WRITE(UNIT,53990)X,TX,PCNT,UX,UTX,UPCNT
53990 FORMAT(22X,'AVERAGE',8X,F7.2,7X,F7.2,6X,F7.2/20X,
     *  '(STD. DEV.)',4X,'+-',F7.2,5X,'+-',F7.2,4X,'+-',F7.2/)
53090 CONTINUE
      REWIND UNIT10
      IRTN=1
      GO TO 500
C
C
5000  STOP
      END
C
C
C
```

TABLE A.2 CMBR SUBROUTINE

```
      SUBROUTINE CMBR(F,C,N,L,NN,LL,SF,V,VK,TOTALA,SSET,
     * KSTARK,SAS,SAA,SR2,R2LS,VIF,
     * RIDGE,EFVAR,INTCEP,IERR,KBUG,CWT,
     * W,X,Y,XMEAN,XPX,XPXK,XPY,SX,S,TM,A,SOLD,IS,IA,ITM
     * )
C     THIS SUBPROGRAM PERFORMS THE CMB ANALYSIS
C     OPTIONS ARE RIDGE REGRESSION,
C     EFFECTIVE VARIANCE METHOD,
C     AND INCLUSION OF INTERCEPT
C
C
C     WRITTEN BY D.A. DUBOSE AND H.J. WILLIAMSON
C     RADIAN CORPORATION,AUSTIN TEXAS IN 1982
C     UNDER CONTRACT TO EPA (PROJECT OFFICER W.P. FREAS)
C
C
C ***********ARGUMENTS  TO THE SUBPROGRAM**************************
C
C        ***************** INPUT *********************
C
C     F-SOURCE SIGNATURE MATRIX
C     C-CONCENTRATION VECTOR
C     SF-STANDARD ERROR OF F
C     V-STANDARD ERROR OF C
C     N-NUMBER OF SPECIES
C     L-NUMBER OF SOURCES
C     NN-MAXIMUM NUMBER OF SPECIES(ARRAY DIMENSION)
C     LL-MAXIMUM NUMBER OF SOURCES(ARRAY DIMENSION)
C     VK-VECTOR OF K-VALUES FOR RIDGE REGRESSION
C     TOTALA-TOTAL AEROSOL
C
C
C ***************** CONTROL*********************
C
C     RIDGE-RIDGE OPTION FLAG 0=NO 1=YES 2=YES +SUMMARY
C     EFVAR-EFFECTIVE VARIANCE FLAG 0=NO 1=YES
C     INTCEP-INTERCEPT OPTION FLAG 0=NO 1=YES
C     CWT-WEIGHT FOR RIDGE SOLUTION SELECTION
C     KBUG-NOT USED IN THIS VERSION
C
C
C ***************** OUTPUT **********************
C
C     SSET-STANDARD ERROR OF CALCULATED TOTAL AEROSOL
C     KSTARK-INDEX OF SELECTED RIDGE SOLUTION
C     SAS-MATRIX OF RIDGE SOLUTIONS
C     SAA-MATRIX OF STANDARD ERRORS OF SAS
C     SR2-R-SQUARE OF SELECTED RIDGE SOLUTION
```

TABLE A.2 CMBR SUBROUTINE (CONTINUED)

```
C     R2LS-R-SQUARE OF LEAST SQUARES SOLUTION
C     VIF-VARIANCE INFLATION FACTORS
C     IERR-INVERSION ERROR FLAG
C
C
C ********************* WORKSPACE ********************
C
C     W-WEIGHTS
C     X-SCALED SIGNATURE
C     Y-SCALED CONCENTRATIONS
C     XMEAN-SOURCE MEANS
C     XPX-X'X MATRIX (CORRELATION MATRIX)
C     XPXK-XPX INVERSE
C     XPY-X'Y VECTOR
C     SX-SOURCE SCALE FACTORS
C     S-SOLUTION VECTOR
C     TM-MATRIX MULTIPLICATION WORK SPACE
C     A-STANDARD ERROR OF SOLUTION VECTOR S
C     SOLD  -HOLDER FOR SOLUTION TO CHECK FOR CONVERGENCE
C     IA-WORKSPACE FOR INVERSION ROUTINE
C     ITM  -WORKSPACE FOR INVERSION ROUTINE
C     IS  -WORKSPACE FOR INVERSION ROUTINE
C
C
C
C ******** OTHER VARIBLES AND ARRAYS*************
C
C     ADIF-RIDGE SELECTION CLOSENESS CRITERIA VALUE
C     AINT-INTERCEPT
C     DET-ARGUMENT FOR INVERSION ROUTINE(DETERMINENT)
C     DF-DEGREES OF FREEDOM
C     EPS-ARGUMENT FOR INVERSION ROUTINE
C     IAGAIN-REITERATION FLAG
C     IBLANK-BLANK ' '
C     IN-NUMBER OF NEGATIVE SOLUTIONS
C     ITER-ITERATION NUMBER
C     KALL-NUMBER OF RIDGE K-VALUES
C     KINDEX  -  INDEX OF RIDGE SOLUTION
C     LP1-L PLUS ONE FOR INTERCEPT IF REQUESTED
C     MAXIT-MAXIMUM NUMBER OF ITERATIONS
C     MORE-NUMBER OF ADDITIONAL ITERATIONS
C     MSE-MEAN SQUARE ERROR
C     NPIV,PIV-ARGUMENTS FOR INVERSE ROUTINE
C     SE-STANDARS ERROR(SQRT MSE)
C     SET-STANDARD ERROR OF CALCULATED TOTAL AEROSOL
C     SSE-SUM OF SQUARES FOR ERROR
C     SY-CONCENTRATION SCALE FACTOR
C     SYSX-SCALE FACTOR FOR COEFFICIENTS
```

TABLE A.2 CMBR SUBROUTINE   (CONTINUED)

```
C     UNIT5,UNIT6-FORTRAN READ/WRITE UNITS
C     WORST-VALUE OF NEGATIVE COEFFICIENTS OF GREATEST MAGNITUDE
C     WT-WEIGHT(OFTEN USED AS WORK VARIABLE)
C     STARK-K-VALUE OF BEST RIDGE SOLUTION TO DATE
C     SUMNEG-NEGATIVE COEFFICIENT RIDGE SELECTION CRITERIA VALUE
C     SUMWT-RIDGE SELECTION CLOSENESS(ALSO WORK SPACE)
C     SXM-WORK VARIABLE
C
C ********************************************************************
      REAL F(NN,LL), C(NN), V(NN), SF(NN,LL), VK(31),
     * X(NN,LL),SAS(LL,31),SAA(LL,31),VIF(LL),
     *  Y(NN),XMEAN(LL),XPX(LL,LL),XPXK(LL,LL),
     * XPY(LL), SX(LL), S(LL), TM(NN), A(LL), SOLD(LL),W(NN),SSET(2)
      INTEGER IS(LL),IA(LL),ITM(NN),UNIT5,UNIT6
      REAL K,MSE
      INTEGER EFVAR,RIDGE
      DATA IBLANK/' '/
C
      UNIT5=5
      UNIT6=6
      KALL=31
C
      EPS=0.
      ADIFF=1.E30
      KINDEX=1
      DO 2020 I=1,N
      W(I)=V(I)
 2020 CONTINUE
      KBUG=0
CONTROL POINT - BEGIN CYCLE FOR K-VALUE
 3000 CONTINUE
      K=VK(KINDEX)
      MAXIT=10
      ITER=1
      IF(EFVAR.EQ.0 .AND. KINDEX.GT.1) GO TO 9000
CONTROL POINT - BEGIN ITERATION LOOP
 4000 CONTINUE
COMPUTE WEIGHTS & WEIGHTED MEANS
      SUMWT=0.
      YMEAN=0.
      DO 5005 J=1,L
 5005 XMEAN(J)=0.
      DO 5008 I=1,N
      W(I)=1./W(I)
 5008 CONTINUE
      LP1=L
      IF(INTCEP.EQ.0) GO TO 6000
CORRECT SOURCE MATRIX TO INCLUDE INTERCEPT TERM
```

TABLE A.2 CMBR SUBROUTINE   (CONTINUED)

```
      LP1=L+1
      DO 5020 I=1,N
      F(I,LP1)=1.0
 5020 CONTINUE
 6000 CONTINUE
CALCULATE VARIANCE STABILIZATION BY WEIGHTING
      DO 6020 I=1,N
      DO 6010 J=1,LP1
      X(I,J) = F(I,J)*W(I)
 6010 CONTINUE
      Y(I)=C(I)*W(I)
 6020 CONTINUE
COMPUTE STANDARDIZING FACTORS
      DO 6060 J=1,LP1
      WT=0.
      DO 6050 I=1,N
      WT=WT+X(I,J)**2
 6050 CONTINUE
      SX(J)=SQRT(WT)
 6060 CONTINUE
      SY=0.
      DO 6070 I=1,N
      SY=SY+Y(I)**2
 6070 CONTINUE
      SY=SQRT(SY)
COMPUTE STANDARDIZED DATA VALUES
      DO 6090 I=1,N
      DO 6080 J=1,LP1
      X(I,J)=X(I,J)/SX(J)
 6080 CONTINUE
      Y(I)=Y(I)/SY
 6090 CONTINUE
COMPUTE MATRIX OF SUM OF SQUARES AND CROSS PRODUCTS
      DO 7030 J=1,LP1
      DO 7020 M=1,J
      WT=0
      DO 7010 I=1,N
      WT=WT + X(I,M) * X(I,J)
 7010 CONTINUE
      XPX(M,J) = WT
      XPX(J,M) = WT
 7020 CONTINUE
      WT=0
      DO 7025 I=1,N
      WT=WT + X(I,J)*Y(I)
 7025 CONTINUE
      XPY(J)=WT
 7030 CONTINUE
```

TABLE A.2 CMBR SUBROUTINE (CONTINUED)

```
CHECKPOINT - ADD RIDGE TO SSCP MATRIX
 9000 CONTINUE
      DO 9050 M=1,LP1
      I=M-1
      DO 9040 J=1,I
      XPXK(M,J)=XPX(M,J)
      XPXK(J,M)=XPX(M,J)
 9040 CONTINUE
      XPX(M,M)=1.0 + K
      XPXK(M,M)=XPX(M,M)
 9050 CONTINUE
CALL INVERSE ROUTINE
      CALL INV1(XPXK,LP1,LL,EPS,IS,IERR,DET,NPIV,PIV,IA,ITM)
      IF(IERR.EQ.0)GO TO 10000
      WRITE(UNIT6,9090)
 9090 FORMAT(' ***ERROR: SINGULAR MATRIX, CHECK DATA')
      IERR=1
      GO TO 99900
COMPUTE SOLUTION VECTOR
10000 CONTINUE
      DO 10020 J=1,LP1
      WT=0.
      DO 10010 M=1,LP1
      WT=WT + XPXK(J,M)*XPY(M)
10010 CONTINUE
      S(J)=WT
10020 CONTINUE
COMPUTE R-SQUARED
      SSE=0.
      DO 12020 I=1,N
      WT=0.
      DO 12010 J=1,LP1
      WT=WT + X(I,J)*S(J)
12010 CONTINUE
      WT=Y(I)-WT
      SSE=SSE+WT*WT
12020 CONTINUE
      WT=0.
      IF(INTCEP.EQ.1)WT=XPY(LP1)**2
      R2=1-SSE/(1-WT)
      DF=N-LP1
      MSE=SSE/DF
      SE=SQRT(MSE)
COMPUTE STANDARD ERRORS
      SET=0.0
      DO 14030 M=1,LP1
      DO 14020 J=1,LP1
      WT=0
```

TABLE A.2 CMBR SUBROUTINE (CONTINUED)

```
      DO 14010 I=1,LP1
      WT=WT + XPXK(M,I)*XPX(I,J)
14010 CONTINUE
      TM(J)=WT - K*XPXK(M,J)
14020 CONTINUE
      WT=0
      DO 14025 J=1,LP1
      WT= WT + TM(J)*XPXK(J,M)
COMPUTE DATA SCALE STANDARD ERROR OF TOTAL AEROSOL
      SXM=SX(M)
      DO 14025 I=1,LP1
      SET=SET+TM(J)/SXM*XPXK(J,I)/SX(I)
14025 CONTINUE
      A(M)=SE*SQRT(WT)
14030 CONTINUE
      SET=SQRT(SY*SET)
COMPUTE DATA SCALE SOLUTION AND STANDARD ERRORS
      AINT=0.0
      DO 16020 J=1,LP1
      SYSX=SY/SX(J)
      S(J)=S(J)*SYSX
      A(J)=A(J)*SYSX
16020 CONTINUE
      IF(INTCEP.NE.0)AINT=S(LP1)
COMPUTE EFFECTIVE VARIANCES
      IF(EFVAR.EQ.0) GO TO 20000
      DO 17030 I=1,N
      WT=V(I)**2
      DO 17020 J=1,L
      SYSX=S(J)*SF(I,J)
      WT=WT + SYSX*SYSX
17020 CONTINUE
      W(I)=SQRT(WT)
17030 CONTINUE
CHECK FOR CONVERGENCE
      IAGAIN=0
      IF(ITER.EQ.1) GO TO 18050
      DO 18030 J=1,LP1
      WT=ABS(S(J)-SOLD(J))/A(J)
      IF(WT.GT. 0.1) IAGAIN=1
18030 CONTINUE
      IF(IAGAIN.EQ.0 .OR. ITER.GE.MAXIT) GO TO 20000
18050 ITER=ITER+1
      DO 18070 J=1,LP1
      SOLD(J)=S(J)
18070 CONTINUE
CIRCLE BACK FOR ANOTHER ITERATION
      GO TO 4000
```

TABLE A.2 CMBR SUBROUTINE   (CONTINUED)

```
COMPLETED ITERATION FOR THIS K
20000 CONTINUE
      SSE=SSE*SY*SY
COMPUTE TOTAL AEROSOL AND # NEGATIVE COEFFICIENTS
      WORST=0.
      SUMNEG=0.
      IN=0
      SUMWT=0.
      DO 20080 J=1,L
      IF(S(J).GE.0.)GO TO 20078
      IN=IN+1
      SUMNEG=SUMNEG+S(J)*S(J)
      IF(S(J).LT.WORST) WORST=S(J)
20078 SUMWT=SUMWT+S(J)
20080 CONTINUE
      SUMWT=SUMWT+AINT
       IF(RIDGE.NE.2) GO TO 21099
      IF(KINDEX.EQ.1)WRITE(UNIT6,21085)
21085 FORMAT(/' RIDGE K',2X,'R-SQUARE',3X,'AEROSOL',3X,'SE(AEROSOL)',
     * 2X,'# NEG',4X,'WORST',2X, 'ITERATIONS')
      WRITE(UNIT6,21086)K,R2,SUMWT,SET,IN,WORST,ITER
21086 FORMAT(2X,F5.3,4X,F6.4,3X,F8.3,3X,F8.2,6X,I2,F11.3,5X,
     *  I3)
21099 CONTINUE
       IF(ITER.LT.MAXIT .OR. IAGAIN.EQ.0)GO TO 28000
22149 IF(RIDGE.GT.0)WRITE(UNIT6,22150)ITER,K
22150 FORMAT(' ',I3,' ITERATIONS SO FAR FOR RIDGE K=',F5.3,
     * ' WITHOUT CONVERGENCE'/' HOW MANY MORE DO YOU WANT TO ',
     * 'TRY?')
      IF(RIDGE.EQ.0)WRITE(UNIT6,22151)ITER
22151 FORMAT(' ',I3,' ITERATIONS SO FAR WITHOUT CONVERGENCE'/
     *  ' HOW MANY MORE DO YOU WANT TO TRY?')
      READ(UNIT5,22152,ERR=22149)MORE,I
22152 FORMAT(I2,T2,A1)
      IF(I.EQ.IBLANK)MORE=MORE/10
      ITER=ITER+1
      MAXIT=MAXIT+MORE
      IF (MAXIT.GT.ITER)GO TO 4000
28000 CONTINUE
CHOCK AWAY COEFFICIENTS, ETC. FOR THIS RIDGE K SOLUTION
      IF(KINDEX.EQ.1)SSET(1)=SET
      DO 27030 J=1,LP1
      SAS(J,KINDEX)=S(J)
      SAA(J,KINDEX)=A(J)
27030 CONTINUE
COMPUTE VARIANCE INFLATION FACTORS
      IF(K.NE.0.0) GO TO 27050
      R2LS=R2
```

TABLE A.2 CMBR SUBROUTINE (CONTINUED)

```
      DO 27040 J=1,L
      VIF(J)=XPXK(J,J)
27040 CONTINUE
27050 CONTINUE
CHOOSE BETTER SOLUTION
      SUMWT=(SUMWT-TOTALA)**2 + CWT*SUMNEG
      IF(SUMWT.GT.ADIFF) GO TO 40000
      ADIFF=SUMWT
      STARK=K
      KSTARK=KINDEX
      SR2=R2
      SSET(2)=SET
CHECK FOR LAST OF K-SOLUTIONS
40000 CONTINUE
      IF(KALL.LE.KINDEX .OR. RIDGE.EQ.0) GO TO 50000
      KINDEX=KINDEX+1
CIRCLE BACK FOR ANOTHER K-VALUE
      GO TO 3000
COMPLETED ALL K-VALUES
50000 CONTINUE
      IF(RIDGE.GE.2)WRITE(UNIT6,50010) STARK
50010 FORMAT('0RIDGE K= ',F5.3,' IS THE SELECTED BEST SOLUTION')
99900 RETURN
      END
```

TABLE A.3 FETCH SUBROUTINE

```
C
C
C
C  FETCH - ACCESSES INPUT DATA STORAGE
C
C  MODIFIED 1982 BY D.A. DUBOSE OF RADIAN CORP,AUSTIN TX
C  UNDER CONTRACT TO US EPA
C
C
C  ICNTRLS:
C     0- AUTOFIT EOF
C     1- AUTOFIT START
C     2- AUTOFIT IN MID SEARCH
C     4- SELECT START
C     5- SELECT IN MID SEARCH
C     7- BAGKGROUND START
C     8- BAGKGROUND IN MID SEARCH
C     9- DATA SEARCH FAILED
C
      SUBROUTINE FETCH(ASB,INID,DUR,START,
     *CONC,UCONC,FMASS,UFMASS,CMASS,UCMASS,TMASS,UTMASS,
     *MFLAG,SAVE,ICNTRL,TYPE,UNIT6,UNIT12,UNIT13)
C
C
      REAL*4 FMASS,UFMASS,CMASS,UCMASS,TMASS,UTMASS,CONC(35,3),
     *UCONC(35,3),
     *T10,T7,T8,T9
C
C
C
C
C CHARACTER VARIABLES
      INTEGER*4 ASB,SAVE(5),TYPE
     * ,MFLAG(35,3),
     * QUOTM,BLANK,QUOTB,QUOTA,QUOTS,QUOTFT,QUOTFC
C INTEGER SPECS
      INTEGER*4  T0,T6,SCODE(35),PCODE(35),DUR,START,
     * UNIT6,UNIT12,UNIT13
CHARACTER VARIABLE SPECS
      INTEGER*4 INID(5),ID(5)
C
      COMMON /F/ PCODE,SCODE,NEL
C
C     EQUIVALENCE (SITE,INID(1)),(YEAR,INID(4)),(DATE,INID(5))
C
C DATA INITIALIZATION
      DATA QUOTM,BLANK,QUOTB,QUOTA,QUOTS,QUOTFT,QUOTFC /
     *  'M',' ','B','A','S','FT','FC'/
```

TABLE A.3 FETCH SUBROUTINE (CONTINUED)

```
C
C
C
C
C
C  FORMAT STATEMENTS
C  TITLE CARD FOR SITE NUMBER AND YEAR AND DATE
   25 FORMAT(5X,' SITE: ',3A4,5X,'YEAR: ',A2,2X,'DATE: ',A4,5X,A2)
C  POLLUTANT DATA CARDS
155   FORMAT(I2,1X,3A4,1X,A2,A4,1X,I2,1X,I2,4X,I2,2X,
     *F9.4,2X,F9.4,2X,F9.4,2X,F9.4)
C
C
C  DATA SEARCH FAILURE
410   FORMAT(1H ,'DATA SET NOT FOUND FOR'/6X,'SITE: ',
     *  3A4,5X,'YEAR: ',A2,2X,'DATE: ',A4/
     * ' USE ONE OF THOSE LISTED ABOVE')
C
C
C
C
C
C INITIALIZE CONCS,MASSES AND MISSING DATA FLAGS
      DO 3 I=1,NEL
      DO 3 J=1,3
      CONC(I,J)=0.000
      UCONC(I,J)=0.001
      MFLAG(I,J)=QUOTM
3     CONTINUE
      FMASS=0.000
      UFMASS=0.000
      CMASS=0.000
      UCMASS=0.000
      TMASS=0.000
      UTMASS=0.000
C
C
C
C
C
C
C
C REWIND DATA FILE
4      REWIND UNIT13
C
C
C
C
```

TABLE A.3 FETCH SUBROUTINE   (CONTINUED)

```
C  READ DATA LINE
10     READ (UNIT13,155,END=200)T0,ID,IDUR,ISTART,T6,T7,T8,T9,T10
C
C
C
C
C
C
C
C
C
C  ROUTE CARD TYPES
       IF(T0.EQ.3)GO TO 30
       IF(T0.EQ.30.AND.ICNTRL.EQ.2)GO TO 150
       IF(T0.EQ.30.AND.ICNTRL.EQ.5)GO TO 150
       IF(T0.EQ.30.AND.ICNTRL.EQ.8)GO TO 150
       GO TO 10
C
C
C
C
CONTROL POINT - CARD TYPE 3 (SITE HEADER CARD)
    30 CONTINUE
       DO 35 I=1,5
       SAVE(I)=ID(I)
    35 CONTINUE
C  CHECK CONTROLS
       IF(ICNTRL.EQ.2)GO TO 320
       IF(ICNTRL.EQ.8)GO TO 320
       IF(ICNTRL.EQ.5)GO TO 320
       TYPE=QUOTFC
       IF(T6.EQ.13)TYPE=QUOTFT
       WRITE(UNIT6,25)ID,TYPE
C MATCH INID
       DO 37 I=1,5
       IF(ID(I).NE.INID(I))GO TO 10
37     CONTINUE
       DUR=IDUR
       START=ISTART
       IF(ASB.NE.QUOTB)WRITE(UNIT12,155) T0,ID,DUR,START,T6
C ADJUST CONTROLS
       IF(ASB.EQ.QUOTA)ICNTRL=2
       IF(ASB.EQ.QUOTB)ICNTRL=8
       IF(ASB.EQ.QUOTS)ICNTRL=5
C  BACK TO READ
       GO TO 10
C
C
```

TABLE A.3 FETCH SUBROUTINE (CONTINUED)

```
C
C
C
C
C
C
C  POLLUTANT CARDS
150   CONTINUE
C  CHECK IF POLLUTANT IS MASS
      IF(T6.NE.01)GO TO 168
C
165   IF(TYPE .NE. QUOTFT)GO TO 167
      FMASS=T7
      UFMASS=T8
      TMASS=T9
      UTMASS=T10
      CALL COARS(CMASS,UCMASS,TMASS,UTMASS,FMASS,UFMASS)
      GO TO 168
167   FMASS=T7
      UFMASS=T8
      CMASS=T9
      UCMASS=T10
      TMASS=CMASS+FMASS
      UTMASS=SQRT(UCMASS*UCMASS+UFMASS*UFMASS)
      GO TO 168
C MATCH POLLUTANT CONCENTRATIONS
168   DO 172 I=1,NEL
      IF(T6.EQ.PCODE(I))GO TO 169
      GO TO 172
169   IF(TYPE .NE. QUOTFT)GO TO 170
      CONC(I,1)=T7
      UCONC(I,1)=T8
      CONC(I,3)=T9
      UCONC(I,3)=T10
      IF(CONC(I,1).EQ.0.000.AND.UCONC(I,1).EQ.0.000)UCONC(I,1)=000.001
      IF(CONC(I,3).EQ.0.000.AND.UCONC(I,3).EQ.0.000)UCONC(I,3)=000.001
      CALL COARS(CONC(I,2),UCONC(I,2),CONC(I,3),UCONC(I,3),
     *CONC(I,1),UCONC(I,1))
      GO TO 171
170   CONC(I,1)=T7
      UCONC(I,1)=T8
      CONC(I,2)=T9
      UCONC(I,2)=T10
      CONC(I,3)=CONC(I,1)+CONC(I,2)
      UCONC(I,3)=SQRT(UCONC(I,1)**2+UCONC(I,2)**2)
      IF(CONC(I,1).EQ.0.000.AND.UCONC(I,1).EQ.0.000)UCONC(I,1)=000.001
      IF(CONC(I,2).EQ.0.000.AND.UCONC(I,2).EQ.0.000)UCONC(I,2)=000.001
      IF(CONC(I,3).EQ.0.000.AND.UCONC(I,3).EQ.0.000)UCONC(I,3)=000.001
```

TABLE A.3 FETCH SUBROUTINE (CONTINUED)

```
C ADJUST MISSING DATA FLAGS
171   MFLAG(I,1)=BLANK
      MFLAG(I,2)=BLANK
      MFLAG(I,3)=BLANK
172   CONTINUE
C IF SELECT OR AUTOFIT,WRITE TEMP LINE
175   IF(ASB.NE.QUOTB)WRITE(UNIT12,155)TO,INID,DUR,START,T6,T7,T8,T9,
     * T10
C ADJUST CONTROLS
      IF(ASB.EQ.QUOTA)ICNTRL=2
      IF(ASB.EQ.QUOTB)ICNTRL=8
      IF(ASB.EQ.QUOTS)ICNTRL=5
C BACK TO READ
      GO TO 10
C
C
C
C
C
C
C  END OF FILE
200   IF(ICNTRL.EQ.1)GO TO 400
      IF(ICNTRL.EQ.7)GO TO 400
      IF(ICNTRL.EQ.4)GO TO 400
      IF(ICNTRL.EQ.2)ICNTRL=0
      GO TO 320
C
C
C
C
C
C
C RETURN TO MAIN
320   RETURN
C
C
C  DATA SEARCH FAILED
400   WRITE(UNIT6,410)INID
      ICNTRL=9
      RETURN
      END
C
```

TABLE A.4 COARS SUBROUTINE

```
C  SUBROUTINE COARS
C  FOR PROGRAM CMB
C  BY DR. J.G.WATSON
C    GETS COARSE FRACTION AND UNCERTAINTY
C
      SUBROUTINE COARS(X,UX,TCONC,UTCONC,FCONC,UFCONC)
      IF(UTCONC.EQ.-1..OR.UFCONC.EQ.-1.)GO TO 10
      X=TCONC-FCONC
      UX=(UTCONC**2+UFCONC**2)**.5
      IF(X.LT.UX)X=UX/2.
      RETURN
10    X=-1.
      UX=-1.
      RETURN
      END
```

TABLE A.5 PERC SUBROUTINE

```
C
C
C
C SUBROUTINE PERC
C FOR PROGRAM CMB
C BY D. W. TORKELSON
C    THIS ROUTINE CALCULATES PERCENTS AND THEIR UNCERTAINTIES
C
      SUBROUTINE PERC(PCNT,UPCNT,X1,UX1,X2,UX2)
      REAL*4 PCNT,UPCNT,X1,UX1,X2,UX2
      IF(X2.EQ.0.)GO TO 5
      IF(X1.EQ.-1..OR.X2.EQ.-1.)GO TO 15
      PCNT=100.*(X1/X2)
      UPCNT=100.*((UX1/X2)**2+(UX2*X1/X2**2)**2)**.5
      IF(PCNT.LT.UPCNT)PCNT=UPCNT/2.
      GO TO 10
5     PCNT=0.
      UPCNT=0.
10    RETURN
15    PCNT=-1.
      UPCNT=-1.
      RETURN
      END
C
```

TABLE A.6 INV1 SUBROUTINE

```
      SUBROUTINE INV1(A,N,NN,EPS,LTEMP,IERR,DET,NPIV,PIV,LPR,LPC)       INVO
      DIMENSION A(NN,NN)                                                INVO
      DIMENSION LTEMP(1),LPR(1),LPC(1)                                  INVO
C                                                                       INVO
C DECK 8045A                                                            INVO
C                                                                       INVO
C SUBROUTINES CALLED - NONE                                             INVO
C                                                                       INVO
C THIS ROUTINE INVERTS MATRIX A IN ITS OWN SPACE. IT ALSO COMPUTES THE  INVO
C THE DETERMINANT OF A.                                                 INVO
C                                                                       INVO
C THE METHOD IS THE USUAL GAUSSIAN EXCHANGE PROCESS. BOTH ROWS AND      INVO
C COLUMNS ARE SEARCHED FOR MAXIMAL PIVOTS. THERE IS NO UNNECESSARY      INVO
C INTERCHANGING OF ROWS OR COLUMNS, ALL SUCH INTERCHANGES BEING CARRIED INVO
C OUT AFTER THE EXCHANGE PROCESS IS COMPLETE. CHAPTER 1 OF E.L. STIEFLE,INVO
C INTRODUCTION TO NUMERICAL MATHEMATICS,ACADEMIC PRESS,N.Y.,1963,SHOULD INVO
C BE HELPFUL IN FOLLOWING THE CODE.                                     INVO
C                                                                       INVO
C THE CALLING PROGRAM MUST SET A,N,NN,EPS,AND LTEMP TO-                 INVO
C                                                                       INVO
C     A-THE MATRIX TO BE INVERTED                                       INVO
C                                                                       INVO
C     N-THE ORDER OF A                                                  INVO
C                                                                       INVO
C     NN-THE NUMBER OF WORDS OF STORAGE PROVIDED FOR EACH COLUMN        INVO
C        OF ARRAY A BY THE CALLING PROGRAM                              INVO
C                                                                       INVO
C     EPS-A NON-NEGATIVE NUMBER WHICH EACH PIVOT IS REQUIRED TO EXCEED  INVO
C         IN ABSOLUTE VALUE (CUSTOMARILY ZERO)                          INVO
C                                                                       INVO
C     LTEMP-A BLOCK OF AT LEAST N WORDS OF TEMPORARY INTEGER STORAGE    INVO
C                                                                       INVO
C IN ADDITION TO OVERWRITING A WITH ITS INVERSE,THE ROUTINE ALSO SETS   INVO
C IERR,DET,NPIV,PIV,LPR,AND LPC TO-                                     INVO
C                                                                       INVO
C     IERR- 0 IF INVERSION IS COMPLETED AND NO TROUBLE IS DETECTED      INVO
C                                                                       INVO
C           2 IF MAGNITUDE OF CURRENT PIVOT FAILS TO EXCEED EPS         INVO
C             (INVERSION WILL NOT BE COMPLETED)                         INVO
C                                                                       INVO
C     DET-PLUS OR MINUS THE PRODUCT OF THE CURRENT AND ALL PREVIOUS     INVO
C         PIVOTS                                                        INVO
C                                                                       INVO
C     NPIV-THE NUMBER OF THE CURRENT PIVOT (FIRST,SECOND,ETC.)          INVO
C                                                                       INVO
C     PIV-THE CURRENT PIVOT                                             INVO
C                                                                       INVO
C     LPR-THE FIRST NPIV POSITIONS LIST THE PIVOT ROW INDICES IN ORDER  INVO
```

TABLE A.6 INV1 SUBROUTINE (CONTINUED)

```
C         OF USE                                                        INV0
C                                                                       INV0
C     LPC-THE FIRST NPIV POSITIONS LIST THE PIVOT COLUMN INDICES IN     INV0
C         ORDER OF USE                                                  INV05
C                                                                       INV05
C DO INITIALIZATIONS                                                    INV0
C                                                                       INV0
      IERR=0                                                            INV0
      DET=1.                                                            INV0
      DO 2 I=1,N                                                        INV0
      LPR(I)=I                                                          INV0
    2 LPC(I)=I                                                          INV0
C                                                                       INV0
C BEGIN EXCHANGE PROCESS                                                INV0
C                                                                       INV
      DO 17 NP=1,N                                                      INV0
      NPIV=NP                                                           INV0
C                                                                       INV0
C SELECT PIVOT                                                          INV06
C                                                                       INV0
      PIV=0.                                                            INV0
      DO 4 K=NP,N                                                       INV07
      I=LPR(K)                                                          INV0
      DO 4 L=NP,N                                                       INV
      J=LPC(L)                                                          INV07
      IF (ABS(A(I,J))-ABS(PIV)) 4,3,3                                   INV0
    3 KPIV=K                                                            INV0
      LPIV=L                                                            INV07
      IPIV=I                                                            INV0
      JPIV=J                                                            INV0
      PIV=A(I,J)                                                        INV07
    4 CONTINUE                                                          INV0
C                                                                       INV0
C UPDATE DETERMINANT AND PIVOT ROW AND COLUMN LISTS                     INV08
C                                                                       INV0
      DET=DET*PIV                                                       INV0
      ITEMP=LPR(NP)                                                     INV08
      LPR(NP)=LPR(KPIV)                                                 INV0
      LPR(KPIV)=ITEMP                                                   INV0
      ITEMP=LPC(NP)                                                     INV08
      LPC(NP)=LPC(LPIV)                                                 INV0
      LPC(LPIV)=ITEMP                                                   INV0
C                                                                       INV09
C                                                                       INV0
C EXIT IF PIVOT TOO SMALL                                               INV0
C                                                                       INV09
      IF (EPS-ABS(PIV)) 8,7,7                                           INV09
    7 IERR=2                                                            INV0
```

TABLE A.6 INV1 SUBROUTINE (CONTINUED)

```
      RETURN
C
C MODIFY PIVOT ROW
C
    8 DO 9 J=1,N
    9 A(IPIV,J)=-A(IPIV,J)/PIV
C
C MODIFY OTHER ROWS
C
      DO 14 I=1,N
      IF(I-IPIV)10,14,10
   10 TEMP=A(I,JPIV)
      IF(TEMP)11,14,11
   11 DO 13 J=1,N
      IF(J-JPIV)12,13,12
   12 A(I,J)=A(I,J)+A(IPIV,J)*TEMP
   13 CONTINUE
   14 CONTINUE
C
C MODIFY PIVOT COLUMN
C
      DO 15 I=1,N
   15 A(I,JPIV)=A(I,JPIV)/PIV
      A(IPIV,JPIV)=-A(IPIV,JPIV)
   17 CONTINUE
C
C END EXCHANGE PROCESS
C
C UNSCRAMBLE ROWS OF INVERSE AND ADJUST SIGN OF DETERMINANT
C
      DO 18 I=1,N
      L=LPR(I)
   18 LTEMP(L)=LPC(I)
      DO 22 I=1,N
   19 K=LTEMP(I)
      IF(I-K)20,22,20
   20 DET=-DET
      DO 21 J=1,N
      TEMP=A(I,J)
      A(I,J)=A(K,J)
   21 A(K,J)=TEMP
      LTEMP(I)=LTEMP(K)
      LTEMP(K)=K
      GO TO 19
   22 CONTINUE
C
C UNSCRAMBLE COLUMNS OF INVERSE
C
```

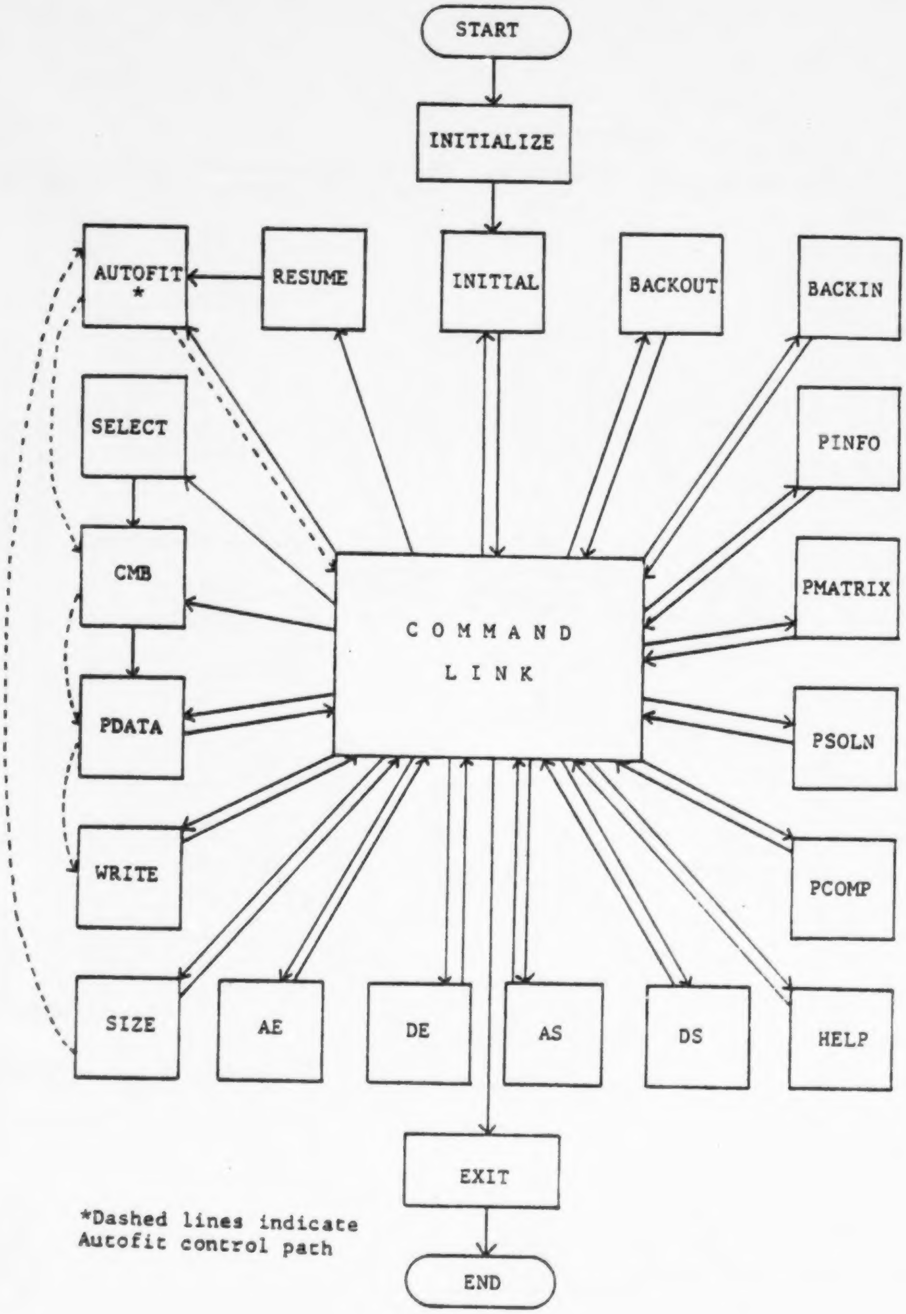
TABLE A.6 INV1 SUBROUTINE (CONTINUED)

```
      DO 23 I=1,N
      L=LPC(I)
   23 LTEMP(L)=LPR(I)
      DO 27 I=1,N
   24 K=LTEMP(I)
      IF(I-K)25,27,25
   25 DO 26 J=1,N
      TEMP=A(J,I)
      A(J,I)=A(J,K)
   26 A(J,K)=TEMP
      LTEMP(I)=LTEMP(K)
      LTEMP(K)=K
      GO TO 24
   27 CONTINUE
      RETURN
      END
```

APPENDIX B

SELECTED FLOW DIAGRAMS

The diagrams presented in this appendix show the relationships among commands, input/output units and subprograms. The diagrams do not give specific details but overall concepts instead.



*Dashed lines indicate Autofit control path

Figure B-1. Generalized Program Flow Diagram

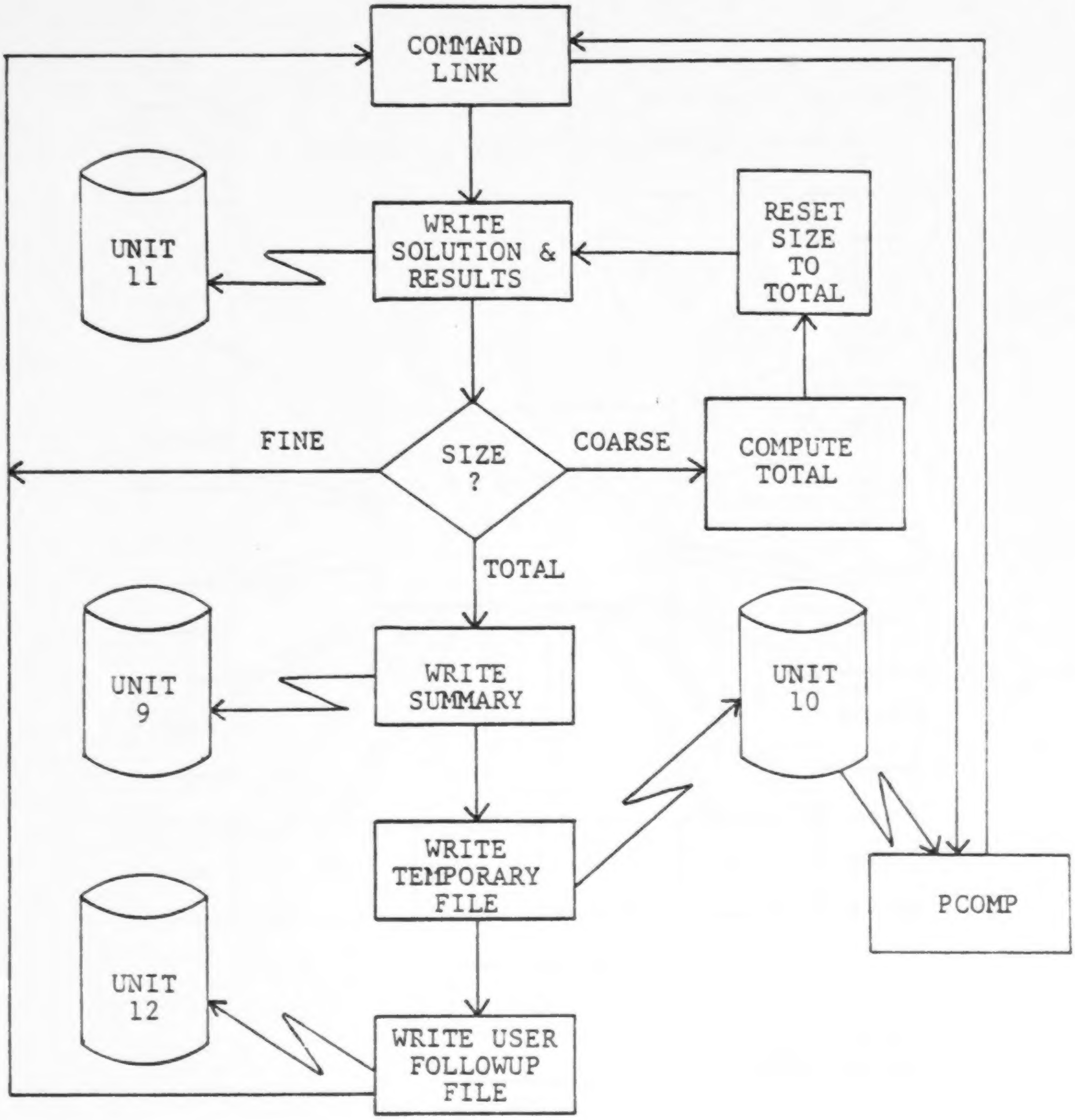


Figure B-2. WRITE Command Flow

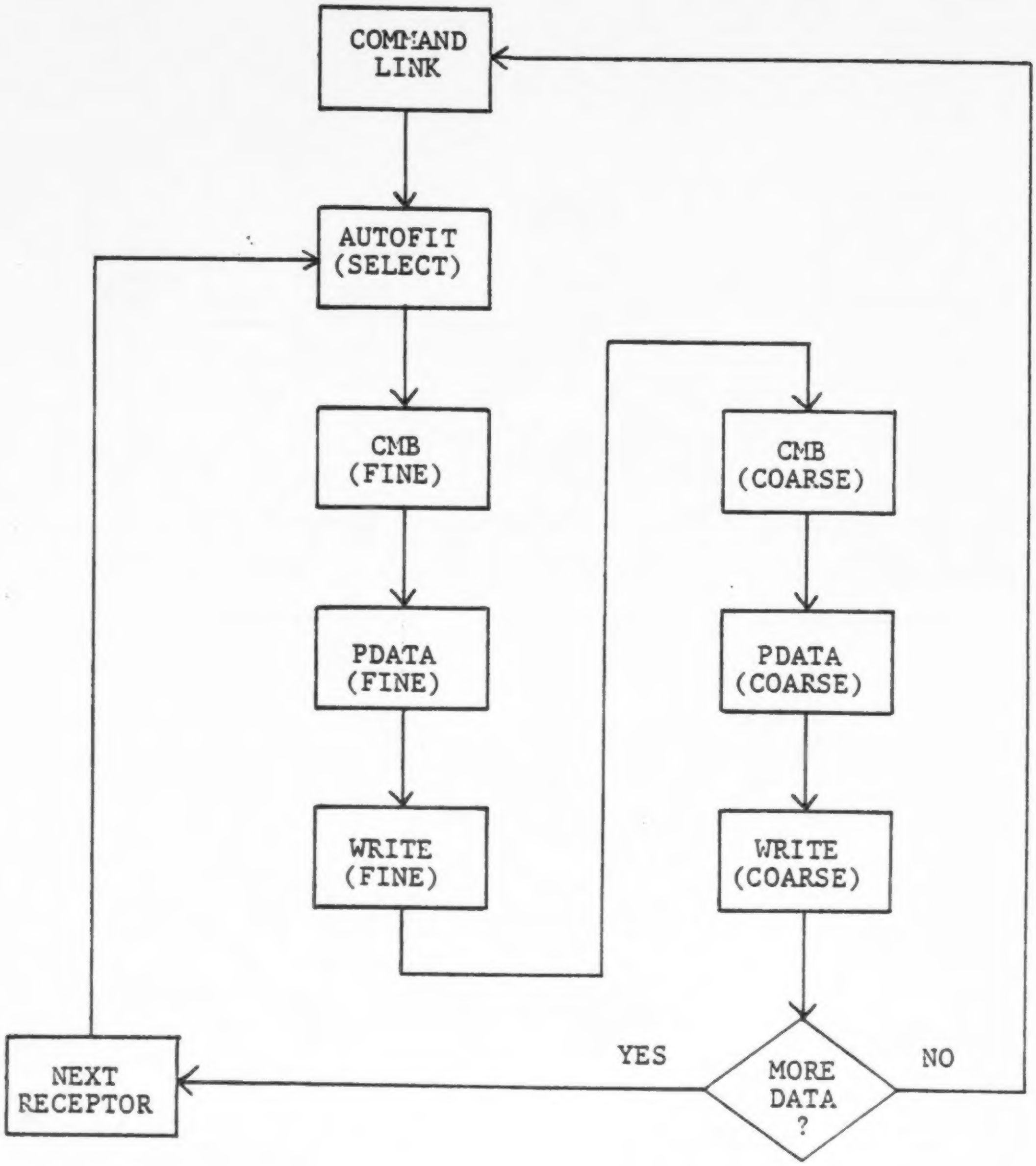


Figure B-3. AUTOFIT Command Flow

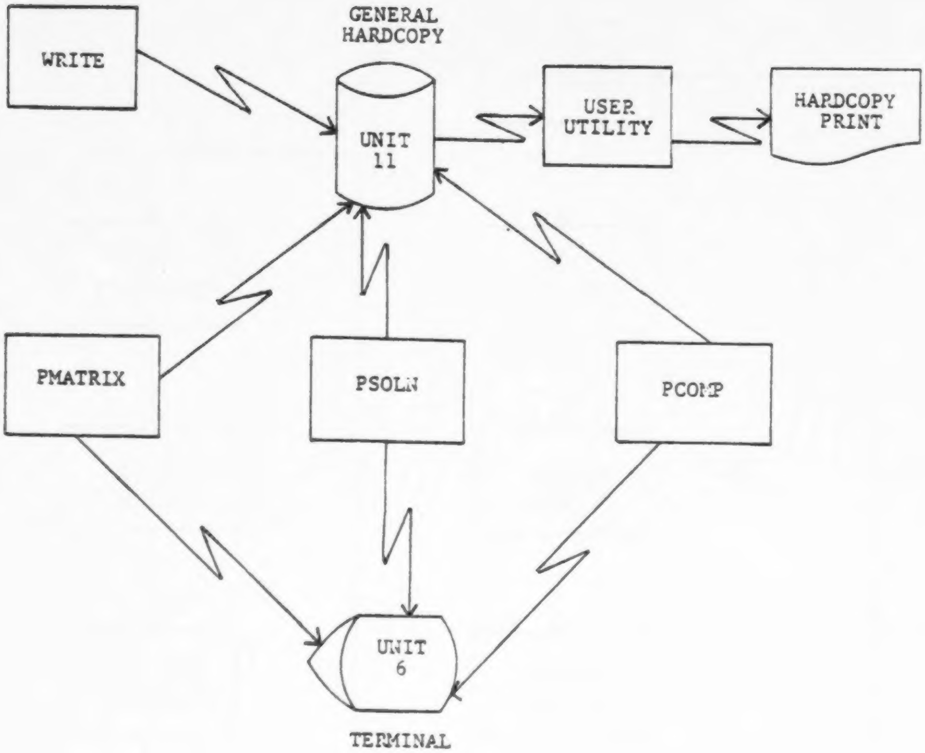


Figure B-4. General Hardcopy Communications

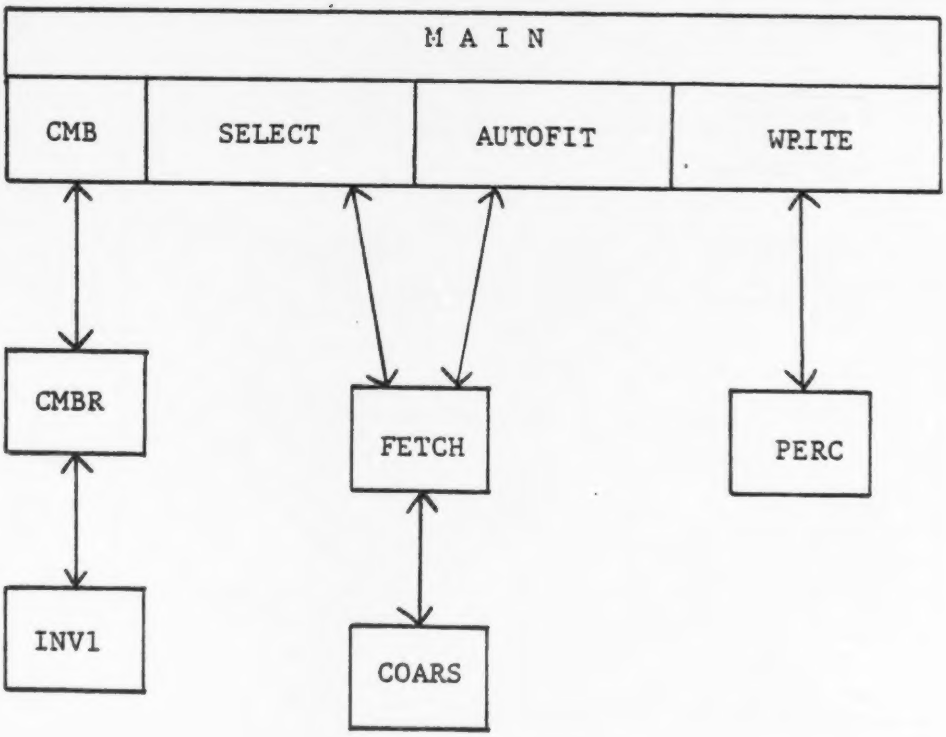
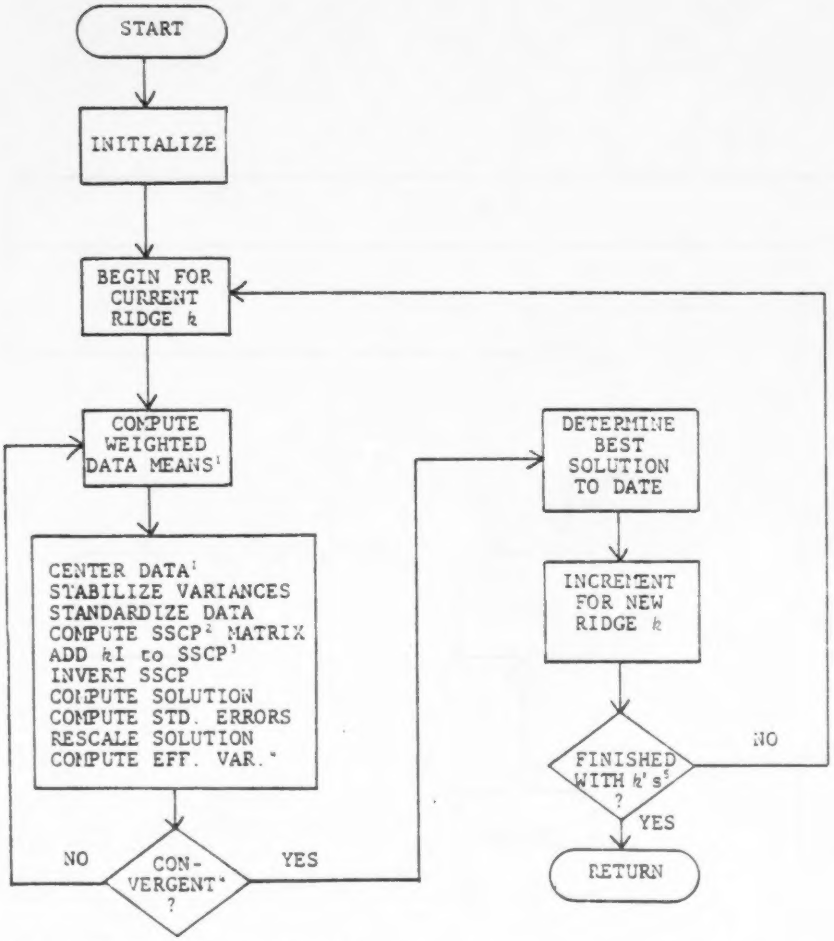


Figure B-5. Relationship of Main Program Commands and Subprogram Linkages



[1] If intercept is called for.
[2] SSCP denotes sum of squares and cross products.
[3] I is the identity matrix.
[4] These items apply if the option to use effective variances is chosen.
[5] If ridge regression is not selected, 0 is the only value of k to be used.

Figure B-6. General CMBR Program Flow Diagram

APPENDIX C

INPUT AND OUTPUT FOR EXAMPLE RUN

This appendix contains example input and output file listings for the CMB program. The data given in Tables C-1 through C-5 are the input files used for the example interactive session of Section 4. The source signature data presented in Tables C-3 and C-4 were compiled by Dzubay and Hasan (1983). Accurate estimates of the standard errors are not currently available for all of the source signatures. A standard error of 25 percent of each source signature entry has been used strictly for illustrative purposes. The printouts given in Tables C-6, C-7, and C-8 are the output files from the interactive session.

TABLE C-1. SOURCE NAME AND CODE INPUT FILE

1	SOIL
2	RD DUST
3	SEA SALT
4	SLSH BRN
5	AUTO CAT
6	AUTO
7	JET AIR
8	RES OIL
9	DIST OIL
10	RES GAS
11	COAL
12	KRAFT RB
13	ELARCFRN
14	FERRMNFR
15	CAL GYP
16	CEMENT
17	PET FCC
18	LSKILN
19	SEC SO4

TABLE C-2. SPECIES NAME AND CODE INPUT FILE

```
 1  TOT
 2  AL
 3  AS
 4  BA
 5  BR
 6  CA
 7  CD
 8  CL
 9  CO
10  CR
11  CU
12  FE
13  HG
14  K
15  MN
16  NI
17  P
18  PB
19  SO4
20  SB
21  SI
22  SN
23  SR
24  TI
25  V
26  ZN
27  C
28  NA
29  NO3
30  RB
31  SE
```

TABLE C-3. FINE FRACTION SOURCE SIGNATURE INPUT FILE

```
 1   2   .006500   .001625   AL       FINE SOIL
 1   3   .000000   .000000   AS       FINE SOIL
 1   4   .000000   .000000   BA       FINE SOIL
 1   5   .000000   .000000   BR       FINE SOIL
 1  27   .000000   .000000   C        FINE SOIL
 1   6   .093000   .023250   CA       FINE SOIL
 1   7   .000000   .000000   CD       FINE SOIL
 1   8   .000000   .000000   CL       FINE SOIL
 1  10   .000000   .000000   CR       FINE SOIL
 1  11   .000300   .000075   CU       FINE SOIL
 1  12   .008300   .002075   FE       FINE SOIL
 1  14   .002000   .000500   K        FINE SOIL
 1  15   .000370   .000093   MN       FINE SOIL
 1  28   .000000   .000000   NA       FINE SOIL
 1  16   .000000   .000000   NI       FINE SOIL
 1  29   .000000   .000000   NO3      FINE SOIL
 1  18   .000140   .000035   PB       FINE SOIL
 1  30   .000020   .000005   RB       FINE SOIL
 1  20   .000000   .000000   SB       FINE SOIL
 1  31   .000000   .000000   SE       FINE SOIL
 1  21   .024000   .006000   SI       FINE SOIL
 1  22   .000000   .000000   SN       FINE SOIL
 1  19   .004500   .001125   SO4      FINE SOIL
 1  23   .000280   .000070   SR       FINE SOIL
 1  24   .001400   .000350   TI       FINE SOIL
 1  25   .000000   .000000   V        FINE SOIL
 1  26   .000220   .000055   ZN       FINE SOIL
 2   2   .088400   .022100   AL       FINE RD DUST
 2   3   .000000   .000000   AS       FINE RD DUST
 2   4   .000000   .000000   BA       FINE RD DUST
 2   5   .000200   .000050   BR       FINE RD DUST
 2  27   .136500   .034125   C        FINE RD DUST
 2   6   .024400   .006100   CA       FINE RD DUST
 2   7   .000000   .000000   CD       FINE RD DUST
 2   8   .000000   .000000   CL       FINE RD DUST
 2  10   .000450   .000112   CR       FINE RD DUST
 2  11   .000300   .000075   CU       FINE RD DUST
 2  12   .060000   .015000   FE       FINE RD DUST
 2  14   .010300   .002575   K        FINE RD DUST
 2  15   .001230   .000307   MN       FINE RD DUST
 2  28   .012500   .003125   NA       FINE RD DUST
 2  16   .000090   .000022   NI       FINE RD DUST
 2  29   .000000   .000000   NO3      FINE RD DUST
 2  18   .003700   .000925   PB       FINE RD DUST
```

TABLE C-3 (CONTINUED)

2	30	.000000	.000000	RB	FINE RD DUST
2	20	.000000	.000000	SB	FINE RD DUST
2	31	.000000	.000000	SE	FINE RD DUST
2	21	.223000	.055750	SI	FINE RD DUST
2	22	.000000	.000000	SN	FINE RD DUST
2	19	.011100	.002775	SO4	FINE RD DUST
2	23	.000000	.000000	SR	FINE RD DUST
2	24	.006400	.001600	TI	FINE RD DUST
2	25	.000230	.000057	V	FINE RD DUST
2	26	.001100	.000275	ZN	FINE RD DUST
3	2	.000000	.000000	AL	FINE SEA SALT
3	3	.000000	.000000	AS	FINE SEA SALT
3	4	.000000	.000000	BA	FINE SEA SALT
3	5	.000000	.000000	BR	FINE SEA SALT
3	27	.000000	.000000	C	FINE SEA SALT
3	6	.010000	.002500	CA	FINE SEA SALT
3	7	.000000	.000000	CD	FINE SEA SALT
3	8	.550000	.137500	CL	FINE SEA SALT
3	10	.000000	.000000	CR	FINE SEA SALT
3	11	.000000	.000000	CU	FINE SEA SALT
3	12	.000000	.000000	FE	FINE SEA SALT
3	14	.010000	.002500	K	FINE SEA SALT
3	15	.000000	.000000	MN	FINE SEA SALT
3	28	.310000	.077500	NA	FINE SEA SALT
3	16	.000000	.000000	NI	FINE SEA SALT
3	29	.000000	.000000	NO3	FINE SEA SALT
3	18	.000000	.000000	PB	FINE SEA SALT
3	30	.000000	.000000	RB	FINE SEA SALT
3	20	.000000	.000000	SB	FINE SEA SALT
3	31	.000000	.000000	SE	FINE SEA SALT
3	21	.000000	.000000	SI	FINE SEA SALT
3	22	.000000	.000000	SN	FINE SEA SALT
3	19	.090000	.022500	SO4	FINE SEA SALT
3	23	.000000	.000000	SR	FINE SEA SALT
3	24	.000000	.000000	TI	FINE SEA SALT
3	25	.000000	.000000	V	FINE SEA SALT
3	26	.000000	.000000	ZN	FINE SEA SALT
4	2	.014400	.003600	AL	FINE SLASH BURN
4	3	.000000	.000000	AS	FINE SLASH BURN
4	4	.000530	.000132	BA	FINE SLASH BURN
4	5	.000530	.000132	BR	FINE SLASH BURN
4	27	.629000	.157250	C	FINE SLASH BURN
4	6	.010700	.002675	CA	FINE SLASH BURN
4	7	.000530	.000132	CD	FINE SLASH BURN
4	8	.055500	.013875	CL	FINE SLASH BURN
4	10	.000000	.000000	CR	FINE SLASH BURN
4	11	.000900	.000225	CU	FINE SLASH BURN

TABLE C-3 (CONTINUED)

4	12	.001900	.000475	FE	FINE SLASH BURN
4	14	.006000	.001500	K	FINE SLASH BURN
4	15	.001200	.000300	MN	FINE SLASH BURN
4	28	.006500	.001625	NA	FINE SLASH BURN
4	16	.000000	.000000	NI	FINE SLASH BURN
4	29	.051000	.012750	NO3	FINE SLASH BURN
4	18	.000530	.000132	PB	FINE SLASH BURN
4	30	.000530	.000132	RB	FINE SLASH BURN
4	20	.000530	.000132	SB	FINE SLASH BURN
4	31	.000000	.000000	SE	FINE SLASH BURN
4	21	.008900	.002225	SI	FINE SLASH BURN
4	22	.000530	.000132	SN	FINE SLASH BURN
4	19	.016000	.004000	SO4	FINE SLASH BURN
4	23	.000530	.000132	SR	FINE SLASH BURN
4	24	.000000	.000000	TI	FINE SLASH BURN
4	25	.000000	.000000	V	FINE SLASH BURN
4	26	.000000	.000000	ZN	FINE SLASH BURN
5	2	.001200	.000300	AL	FINE AUTO W CAT
5	3	.000000	.000000	AS	FINE AUTO W CAT
5	4	.000000	.000000	BA	FINE AUTO W CAT
5	5	.000000	.000000	BR	FINE AUTO W CAT
5	27	.390000	.097500	C	FINE AUTO W CAT
5	6	.001700	.000425	CA	FINE AUTO W CAT
5	7	.000000	.000000	CD	FINE AUTO W CAT
5	8	.000000	.000000	CL	FINE AUTO W CAT
5	10	.000000	.000000	CR	FINE AUTO W CAT
5	11	.000240	.000060	CU	FINE AUTO W CAT
5	12	.001100	.000275	FE	FINE AUTO W CAT
5	14	.000440	.000110	K	FINE AUTO W CAT
5	15	.000150	.000037	MN	FINE AUTO W CAT
5	28	.000000	.000000	NA	FINE AUTO W CAT
5	16	.000150	.000037	NI	FINE AUTO W CAT
5	29	.000000	.000000	NO3	FINE AUTO W CAT
5	18	.000000	.000000	PB	FINE AUTO W CAT
5	30	.000000	.000000	RB	FINE AUTO W CAT
5	20	.000000	.000000	SB	FINE AUTO W CAT
5	31	.000000	.000000	SE	FINE AUTO W CAT
5	21	.005100	.001275	SI	FINE AUTO W CAT
5	22	.000000	.000000	SN	FINE AUTO W CAT
5	19	.500000	.125000	SO4	FINE AUTO W CAT
5	23	.000000	.000000	SR	FINE AUTO W CAT
5	24	.000000	.000000	TI	FINE AUTO W CAT
5	25	.000000	.000000	V	FINE AUTO W CAT
5	26	.000800	.000200	ZN	FINE AUTO W CAT
6	2	.000430	.000108	AL	FINE AUTO
6	3	.000000	.000000	AS	FINE AUTO

TABLE C-3 (CONTINUED)

6	4	.000000	.000000	BA	FINE AUTO
6	5	.082000	.020500	BR	FINE AUTO
6	27	.545000	.136250	C	FINE AUTO
6	6	.000000	.000000	CA	FINE AUTO
6	7	.000000	.000000	CD	FINE AUTO
6	8	.054000	.013500	CL	FINE AUTO
6	10	.000000	.000000	CR	FINE AUTO
6	11	.000040	.000010	CU	FINE AUTO
6	12	.002500	.000625	FE	FINE AUTO
6	14	.000000	.000000	K	FINE AUTO
6	15	.000000	.000000	MN	FINE AUTO
6	28	.000000	.000000	NA	FINE AUTO
6	16	.000000	.000000	NI	FINE AUTO
6	29	.000000	.000000	NO3	FINE AUTO
6	18	.211000	.052750	PB	FINE AUTO
6	30	.000000	.000000	RB	FINE AUTO
6	20	.000000	.000000	SB	FINE AUTO
6	31	.000000	.000000	SE	FINE AUTO
6	21	.000750	.000187	SI	FINE AUTO
6	22	.000000	.000000	SN	FINE AUTO
6	19	.002100	.000525	SO4	FINE AUTO
6	23	.000000	.000000	SR	FINE AUTO
6	24	.000000	.000000	TI	FINE AUTO
6	25	.000000	.000000	V	FINE AUTO
6	26	.000210	.000053	ZN	FINE AUTO
7	2	.000000	.000000	AL	FINE JET AIR
7	3	.000000	.000000	AS	FINE JET AIR
7	4	.000000	.000000	BA	FINE JET AIR
7	5	.000000	.000000	BR	FINE JET AIR
7	27	.960000	.240000	C	FINE JET AIR
7	6	.000000	.000000	CA	FINE JET AIR
7	7	.000000	.000000	CD	FINE JET AIR
7	8	.000000	.000000	CL	FINE JET AIR
7	10	.000000	.000000	CR	FINE JET AIR
7	11	.000000	.000000	CU	FINE JET AIR
7	12	.000000	.000000	FE	FINE JET AIR
7	14	.000000	.000000	K	FINE JET AIR
7	15	.000000	.000000	MN	FINE JET AIR
7	28	.000000	.000000	NA	FINE JET AIR
7	16	.000000	.000000	NI	FINE JET AIR
7	29	.000000	.000000	NO3	FINE JET AIR
7	18	.000000	.000000	PB	FINE JET AIR
7	30	.000000	.000000	RB	FINE JET AIR
7	20	.000000	.000000	SB	FINE JET AIR
7	31	.000000	.000000	SE	FINE JET AIR
7	21	.000000	.000000	SI	FINE JET AIR

TABLE C-3 (CONTINUED)

7	22	.000000	.000000	SN	FINE JET AIR
7	19	.000000	.000000	SO4	FINE JET AIR
7	23	.000000	.000000	SR	FINE JET AIR
7	24	.000000	.000000	TI	FINE JET AIR
7	25	.000000	.000000	V	FINE JET AIR
7	26	.000000	.000000	ZN	FINE JET AIR
8	2	.005300	.001325	AL	FINE RESIDUAL OIL
8	3	.000000	.000000	AS	FINE RESIDUAL OIL
8	4	.000000	.000000	BA	FINE RESIDUAL OIL
8	5	.000130	.000033	BR	FINE RESIDUAL OIL
8	27	.101000	.025250	C	FINE RESIDUAL OIL
8	6	.015800	.003950	CA	FINE RESIDUAL OIL
8	7	.000000	.000000	CD	FINE RESIDUAL OIL
8	8	.000000	.000000	CL	FINE RESIDUAL OIL
8	10	.000470	.000117	CR	FINE RESIDUAL OIL
8	11	.000750	.000187	CU	FINE RESIDUAL OIL
8	12	.029700	.007425	FE	FINE RESIDUAL OIL
8	14	.002800	.000700	K	FINE RESIDUAL OIL
8	15	.000460	.000115	MN	FINE RESIDUAL OIL
8	28	.035000	.008750	NA	FINE RESIDUAL OIL
8	16	.053600	.013400	NI	FINE RESIDUAL OIL
8	29	.006500	.001625	NO3	FINE RESIDUAL OIL
8	18	.001100	.000275	PB	FINE RESIDUAL OIL
8	30	.000000	.000000	RB	FINE RESIDUAL OIL
8	20	.000000	.000000	SB	FINE RESIDUAL OIL
8	31	.000000	.000000	SE	FINE RESIDUAL OIL
8	21	.009600	.002400	SI	FINE RESIDUAL OIL
8	22	.000000	.000000	SN	FINE RESIDUAL OIL
8	19	.481000	.120250	SO4	FINE RESIDUAL OIL
8	23	.000000	.000000	SR	FINE RESIDUAL OIL
8	24	.001100	.000275	TI	FINE RESIDUAL OIL
8	25	.034400	.008600	V	FINE RESIDUAL OIL
8	26	.004000	.001000	ZN	FINE RESIDUAL OIL
9	2	.003100	.000775	AL	FINE DISTILLATE OIL
9	3	.000000	.000000	AS	FINE DISTILLATE OIL
9	4	.000000	.000000	BA	FINE DISTILLATE OIL
9	5	.000260	.000065	BR	FINE DISTILLATE OIL
9	27	.358000	.089500	C	FINE DISTILLATE OIL
9	6	.005000	.001250	CA	FINE DISTILLATE OIL
9	7	.000000	.000000	CD	FINE DISTILLATE OIL
9	8	.012000	.003000	CL	FINE DISTILLATE OIL
9	10	.000000	.000000	CR	FINE DISTILLATE OIL
9	11	.001700	.000425	CU	FINE DISTILLATE OIL
9	12	.001200	.000300	FE	FINE DISTILLATE OIL
9	14	.000180	.000045	K	FINE DISTILLATE OIL
9	15	.000140	.000035	MN	FINE DISTILLATE OIL
9	28	.003200	.000800	NA	FINE DISTILLATE OIL

TABLE C-3 (CONTINUED)

9	16	.000090	.000022	NI	FINE DISTILLATE OIL
9	29	.010000	.002500	NO3	FINE DISTILLATE OIL
9	18	.005400	.001350	PB	FINE DISTILLATE OIL
9	30	.000000	.000000	RB	FINE DISTILLATE OIL
9	20	.000000	.000000	SB	FINE DISTILLATE OIL
9	31	.000000	.000000	SE	FINE DISTILLATE OIL
9	21	.002700	.000675	SI	FINE DISTILLATE OIL
9	22	.000000	.000000	SN	FINE DISTILLATE OIL
9	19	.132000	.033000	SO4	FINE DISTILLATE OIL
9	23	.000000	.000000	SR	FINE DISTILLATE OIL
9	24	.000000	.000000	TI	FINE DISTILLATE OIL
9	25	.000050	.000013	V	FINE DISTILLATE OIL
9	26	.000290	.000072	ZN	FINE DISTILLATE OIL
10	2	.000000	.000000	AL	FINE RESIDENTIAL GAS
10	3	.000000	.000000	AS	FINE RESIDENTIAL GAS
10	4	.000000	.000000	BA	FINE RESIDENTIAL GAS
10	5	.000000	.000000	BR	FINE RESIDENTIAL GAS
10	27	.120000	.030000	C	FINE RESIDENTIAL GAS
10	6	.050000	.012500	CA	FINE RESIDENTIAL GAS
10	7	.000000	.000000	CD	FINE RESIDENTIAL GAS
10	8	.000000	.000000	CL	FINE RESIDENTIAL GAS
10	10	.000000	.000000	CR	FINE RESIDENTIAL GAS
10	11	.000000	.000000	CU	FINE RESIDENTIAL GAS
10	12	.000000	.000000	FE	FINE RESIDENTIAL GAS
10	14	.000000	.000000	K	FINE RESIDENTIAL GAS
10	15	.000000	.000000	MN	FINE RESIDENTIAL GAS
10	28	.000000	.000000	NA	FINE RESIDENTIAL GAS
10	16	.000000	.000000	NI	FINE RESIDENTIAL GAS
10	29	.000000	.000000	NO3	FINE RESIDENTIAL GAS
10	18	.000000	.000000	PB	FINE RESIDENTIAL GAS
10	30	.000000	.000000	RB	FINE RESIDENTIAL GAS
10	20	.000000	.000000	SB	FINE RESIDENTIAL GAS
10	31	.000000	.000000	SE	FINE RESIDENTIAL GAS
10	21	.000000	.000000	SI	FINE RESIDENTIAL GAS
10	22	.000000	.000000	SN	FINE RESIDENTIAL GAS
10	19	.470000	.117500	SO4	FINE RESIDENTIAL GAS
10	23	.000000	.000000	SR	FINE RESIDENTIAL GAS
10	24	.000000	.000000	TI	FINE RESIDENTIAL GAS
10	25	.000000	.000000	V	FINE RESIDENTIAL GAS
10	26	.000000	.000000	ZN	FINE RESIDENTIAL GAS
11	2	.004380	.001095	AL	FINE COAL
11	3	.000000	.000000	AS	FINE COAL
11	4	.000120	.000030	BA	FINE COAL
11	5	.000000	.000000	BR	FINE COAL
11	27	.000000	.000000	C	FINE COAL
11	6	.018180	.004545	CA	FINE COAL
11	7	.000890	.000223	CD	FINE COAL

TABLE C-3 (CONTINUED)

11	8	.000000	.000000	CL	FINE COAL
11	10	.000160	.000040	CR	FINE COAL
11	11	.000210	.000053	CU	FINE COAL
11	12	.043330	.010832	FE	FINE COAL
11	14	.001890	.000472	K	FINE COAL
11	15	.000000	.000000	MN	FINE COAL
11	28	.002420	.000605	NA	FINE COAL
11	16	.000070	.000018	NI	FINE COAL
11	29	.000000	.000000	NO3	FINE COAL
11	18	.006690	.001673	PB	FINE COAL
11	30	.000000	.000000	RB	FINE COAL
11	20	.000290	.000072	SB	FINE COAL
11	31	.000000	.000000	SE	FINE COAL
11	21	.035550	.008888	SI	FINE COAL
11	22	.008240	.002060	SN	FINE COAL
11	19	.096290	.024072	SO4	FINE COAL
11	23	.000000	.000000	SR	FINE COAL
11	24	.001210	.000303	TI	FINE COAL
11	25	.000000	.000000	V	FINE COAL
11	26	.016270	.004068	ZN	FINE COAL
12	2	.002500	.000625	AL	KRAFT REC BOILER
12	3	.000000	.000000	AS	KRAFT REC BOILER
12	4	.000000	.000000	BA	KRAFT REC BOILER
12	5	.001300	.000325	BR	KRAFT REC BOILER
12	27	.019200	.004800	C	KRAFT REC BOILER
12	6	.000000	.000000	CA	KRAFT REC BOILER
12	7	.000000	.000000	CD	KRAFT REC BOILER
12	8	.018000	.004500	CL	KRAFT REC BOILER
12	10	.002800	.000700	CR	KRAFT REC BOILER
12	11	.000210	.000053	CU	KRAFT REC BOILER
12	12	.012000	.003000	FE	KRAFT REC BOILER
12	14	.015000	.003750	K	KRAFT REC BOILER
12	15	.000300	.000075	MN	KRAFT REC BOILER
12	28	.127000	.031750	NA	KRAFT REC BOILER
12	16	.001400	.000350	NI	KRAFT REC BOILER
12	29	.000000	.000000	NO3	KRAFT REC BOILER
12	18	.000130	.000033	PB	KRAFT REC BOILER
12	30	.000000	.000000	RB	KRAFT REC BOILER
12	20	.000000	.000000	SB	KRAFT REC BOILER
12	31	.000000	.000000	SE	KRAFT REC BOILER
12	21	.001500	.000375	SI	KRAFT REC BOILER
12	22	.000000	.000000	SN	KRAFT REC BOILER
12	19	.400000	.100000	SO4	KRAFT REC BOILER
12	23	.000000	.000000	SR	KRAFT REC BOILER
12	24	.000060	.000015	TI	KRAFT REC BOILER
12	25	.000010	.000002	V	KRAFT REC BOILER
12	26	.000690	.000173	ZN	KRAFT REC BOILER

TABLE C-3 (CONTINUED)

13	2	.006500	.001625	AL	FINE ELECTRIC ARC FURN
13	3	.000000	.000000	AS	FINE ELECTRIC ARC FURN
13	4	.000000	.000000	BA	FINE ELECTRIC ARC FURN
13	5	.000000	.000000	BR	FINE ELECTRIC ARC FURN
13	27	.000000	.000000	C	FINE ELECTRIC ARC FURN
13	6	.062000	.015500	CA	FINE ELECTRIC ARC FURN
13	7	.000000	.000000	CD	FINE ELECTRIC ARC FURN
13	8	.018500	.004625	CL	FINE ELECTRIC ARC FURN
13	10	.021000	.005250	CR	FINE ELECTRIC ARC FURN
13	11	.002800	.000700	CU	FINE ELECTRIC ARC FURN
13	12	.319500	.079875	FE	FINE ELECTRIC ARC FURN
13	14	.009200	.002300	K	FINE ELECTRIC ARC FURN
13	15	.087000	.021750	MN	FINE ELECTRIC ARC FURN
13	28	.012600	.003150	NA	FINE ELECTRIC ARC FURN
13	16	.007100	.001775	NI	FINE ELECTRIC ARC FURN
13	29	.000000	.000000	NO3	FINE ELECTRIC ARC FURN
13	18	.007600	.001900	PB	FINE ELECTRIC ARC FURN
13	30	.000000	.000000	RB	FINE ELECTRIC ARC FURN
13	20	.000000	.000000	SB	FINE ELECTRIC ARC FURN
13	31	.000000	.000000	SE	FINE ELECTRIC ARC FURN
13	21	.050000	.012500	SI	FINE ELECTRIC ARC FURN
13	22	.000000	.000000	SN	FINE ELECTRIC ARC FURN
13	19	.025000	.006250	SO4	FINE ELECTRIC ARC FURN
13	23	.000000	.000000	SR	FINE ELECTRIC ARC FURN
13	24	.002000	.000500	TI	FINE ELECTRIC ARC FURN
13	25	.000630	.000158	V	FINE ELECTRIC ARC FURN
13	26	.012000	.003000	ZN	FINE ELECTRIC ARC FURN
14	2	.006400	.001600	AL	FINE FERROMANGANESE FURN
14	3	.000000	.000000	AS	FINE FERROMANGANESE FURN
14	4	.000000	.000000	BA	FINE FERROMANGANESE FURN
14	5	.001600	.000400	BR	FINE FERROMANGANESE FURN
14	27	.105000	.026250	C	FINE FERROMANGANESE FURN
14	6	.013000	.003250	CA	FINE FERROMANGANESE FURN
14	7	.000000	.000000	CD	FINE FERROMANGANESE FURN
14	8	.004200	.001050	CL	FINE FERROMANGANESE FURN
14	10	.000420	.000105	CR	FINE FERROMANGANESE FURN
14	11	.000360	.000090	CU	FINE FERROMANGANESE FURN
14	12	.021000	.005250	FE	FINE FERROMANGANESE FURN
14	14	.105000	.026250	K	FINE FERROMANGANESE FURN
14	15	.173000	.043250	MN	FINE FERROMANGANESE FURN
14	28	.031000	.007750	NA	FINE FERROMANGANESE FURN
14	16	.000000	.000000	NI	FINE FERROMANGANESE FURN
14	29	.057000	.014250	NO3	FINE FERROMANGANESE FURN
14	18	.000450	.000112	PB	FINE FERROMANGANESE FURN
14	30	.000000	.000000	RB	FINE FERROMANGANESE FURN

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TABLE C-3 (CONTINUED)

14	20	.000000	.000000	SB	FINE FERROMANGANESE FURN
14	31	.000000	.000000	SE	FINE FERROMANGANESE FURN
14	21	.009900	.002475	SI	FINE FERROMANGANESE FURN
14	22	.000000	.000000	SN	FINE FERROMANGANESE FURN
14	19	.042000	.010500	SO4	FINE FERROMANGANESE FURN
14	23	.000000	.000000	SR	FINE FERROMANGANESE FURN
14	24	.000460	.000115	TI	FINE FERROMANGANESE FURN
14	25	.000240	.000060	V	FINE FERROMANGANESE FURN
14	26	.005800	.001450	ZN	FINE FERROMANGANESE FURN
15	2	.000000	.000000	AL	FINE CALCINAION OF GYPSUM
15	3	.000000	.000000	AS	FINE CALCINAION OF GYPSUM
15	4	.000000	.000000	BA	FINE CALCINAION OF GYPSUM
15	5	.000000	.000000	BR	FINE CALCINAION OF GYPSUM
15	27	.010000	.002500	C	FINE CALCINAION OF GYPSUM
15	6	.130000	.032500	CA	FINE CALCINAION OF GYPSUM
15	7	.000000	.000000	CD	FINE CALCINAION OF GYPSUM
15	8	.000000	.000000	CL	FINE CALCINAION OF GYPSUM
15	10	.000000	.000000	CR	FINE CALCINAION OF GYPSUM
15	11	.000000	.000000	CU	FINE CALCINAION OF GYPSUM
15	12	.000000	.000000	FE	FINE CALCINAION OF GYPSUM
15	14	.000000	.000000	K	FINE CALCINAION OF GYPSUM
15	15	.000000	.000000	MN	FINE CALCINAION OF GYPSUM
15	28	.000000	.000000	NA	FINE CALCINAION OF GYPSUM
15	16	.000000	.000000	NI	FINE CALCINAION OF GYPSUM
15	29	.000000	.000000	NO3	FINE CALCINAION OF GYPSUM
15	18	.000000	.000000	PB	FINE CALCINAION OF GYPSUM
15	30	.000000	.000000	RB	FINE CALCINAION OF GYPSUM
15	20	.000000	.000000	SB	FINE CALCINAION OF GYPSUM
15	31	.000000	.000000	SE	FINE CALCINAION OF GYPSUM
15	21	.000000	.000000	SI	FINE CALCINAION OF GYPSUM
15	22	.000000	.000000	SN	FINE CALCINAION OF GYPSUM
15	19	.410000	.102500	SO4	FINE CALCINAION OF GYPSUM
15	23	.000000	.000000	SR	FINE CALCINAION OF GYPSUM
15	24	.000000	.000000	TI	FINE CALCINAION OF GYPSUM
15	25	.000000	.000000	V	FINE CALCINAION OF GYPSUM
15	26	.000000	.000000	ZN	FINE CALCINAION OF GYPSUM
16	2	.000000	.000000	AL	FINE CEMENT
16	3	.000000	.000000	AS	FINE CEMENT
16	4	.000000	.000000	BA	FINE CEMENT
16	5	.000000	.000000	BR	FINE CEMENT
16	27	.080000	.020000	C	FINE CEMENT
16	6	.050000	.012500	CA	FINE CEMENT
16	7	.000000	.000000	CD	FINE CEMENT
16	8	.000000	.000000	CL	FINE CEMENT
16	10	.000000	.000000	CR	FINE CEMENT
16	11	.000000	.000000	CU	FINE CEMENT

TABLE C-3 (CONTINUED)

16	12	.000000	.000000	FE	FINE CEMENT
16	14	.020000	.005000	K	FINE CEMENT
16	15	.000000	.000000	MN	FINE CEMENT
16	28	.000000	.000000	NA	FINE CEMENT
16	16	.000000	.000000	NI	FINE CEMENT
16	29	.000000	.000000	NO3	FINE CEMENT
16	18	.000000	.000000	PB	FINE CEMENT
16	30	.000000	.000000	RB	FINE CEMENT
16	20	.000000	.000000	SB	FINE CEMENT
16	31	.000000	.000000	SE	FINE CEMENT
16	21	.025000	.006250	SI	FINE CEMENT
16	22	.000000	.000000	SN	FINE CEMENT
16	19	.600000	.150000	SO4	FINE CEMENT
16	23	.000000	.000000	SR	FINE CEMENT
16	24	.000000	.000000	TI	FINE CEMENT
16	25	.000000	.000000	V	FINE CEMENT
16	26	.000000	.000000	ZN	FINE CEMENT
17	2	.000000	.000000	AL	FINE PETROL FCC UNITS
17	3	.000000	.000000	AS	FINE PETROL FCC UNITS
17	4	.000000	.000000	BA	FINE PETROL FCC UNITS
17	5	.000000	.000000	BR	FINE PETROL FCC UNITS
17	27	.040000	.010000	C	FINE PETROL FCC UNITS
17	6	.000000	.000000	CA	FINE PETROL FCC UNITS
17	7	.000000	.000000	CD	FINE PETROL FCC UNITS
17	8	.000000	.000000	CL	FINE PETROL FCC UNITS
17	10	.000000	.000000	CR	FINE PETROL FCC UNITS
17	11	.000000	.000000	CU	FINE PETROL FCC UNITS
17	12	.010000	.002500	FE	FINE PETROL FCC UNITS
17	14	.000000	.000000	K	FINE PETROL FCC UNITS
17	15	.000000	.000000	MN	FINE PETROL FCC UNITS
17	28	.000000	.000000	NA	FINE PETROL FCC UNITS
17	16	.000000	.000000	NI	FINE PETROL FCC UNITS
17	29	.000000	.000000	NO3	FINE PETROL FCC UNITS
17	18	.000000	.000000	PB	FINE PETROL FCC UNITS
17	30	.000000	.000000	RB	FINE PETROL FCC UNITS
17	20	.000000	.000000	SB	FINE PETROL FCC UNITS
17	31	.000000	.000000	SE	FINE PETROL FCC UNITS
17	21	.000000	.000000	SI	FINE PETROL FCC UNITS
17	22	.000000	.000000	SN	FINE PETROL FCC UNITS
17	19	.500000	.125000	SO4	FINE PETROL FCC UNITS
17	23	.000000	.000000	SR	FINE PETROL FCC UNITS
17	24	.000000	.000000	TI	FINE PETROL FCC UNITS
17	25	.000000	.000000	V	FINE PETROL FCC UNITS
17	26	.000000	.000000	ZN	FINE PETROL FCC UNITS
18	2	.000000	.000000	AL	FINE LS KILN

TABLE C-3 (CONTINUED)

18	3	.000000	.000000	AS	FINE LS KILN
18	4	.000000	.000000	BA	FINE LS KILN
18	5	.000000	.000000	BR	FINE LS KILN
18	27	.400000	.100000	C	FINE LS KILN
18	6	.300000	.075000	CA	FINE LS KILN
18	7	.000000	.000000	CD	FINE LS KILN
18	8	.000000	.000000	CL	FINE LS KILN
18	10	.000000	.000000	CR	FINE LS KILN
18	11	.000000	.000000	CU	FINE LS KILN
18	12	.020000	.005000	FE	FINE LS KILN
18	14	.000000	.000000	K	FINE LS KILN
18	15	.000000	.000000	MN	FINE LS KILN
18	28	.000000	.000000	NA	FINE LS KILN
18	16	.000000	.000000	NI	FINE LS KILN
18	29	.000000	.000000	NO3	FINE LS KILN
18	18	.000000	.000000	PB	FINE LS KILN
18	30	.000000	.000000	RB	FINE LS KILN
18	20	.000000	.000000	SB	FINE LS KILN
18	31	.100000	.025000	SE	FINE LS KILN
18	21	.000000	.000000	SI	FINE LS KILN
18	22	.000000	.000000	SN	FINE LS KILN
18	19	.000000	.000000	SO4	FINE LS KILN
18	23	.000000	.000000	SR	FINE LS KILN
18	24	.000000	.000000	TI	FINE LS KILN
18	25	.000000	.000000	V	FINE LS KILN
18	26	.000000	.000000	ZN	FINE LS KILN
19	2	.000000	.000000	AL	FINE SEC SO4
19	3	.000000	.000000	AS	FINE SEC SO4
19	4	.000000	.000000	BA	FINE SEC SO4
19	5	.000000	.000000	BR	FINE SEC SO4
19	27	.000000	.000000	C	FINE SEC SO4
19	6	.000000	.000000	CA	FINE SEC SO4
19	7	.000000	.000000	CD	FINE SEC SO4
19	8	.000000	.000000	CL	FINE SEC SO4
19	10	.000000	.000000	CR	FINE SEC SO4
19	11	.000000	.000000	CU	FINE SEC SO4
19	12	.000000	.000000	FE	FINE SEC SO4
19	14	.000000	.000000	K	FINE SEC SO4
19	15	.000000	.000000	MN	FINE SEC SO4
19	28	.000000	.000000	NA	FINE SEC SO4
19	16	.000000	.000000	NI	FINE SEC SO4
19	29	.000000	.000000	NO3	FINE SEC SO4
19	18	.000000	.000000	PB	FINE SEC SO4
19	30	.000000	.000000	RB	FINE SEC SO4
19	20	.000000	.000000	SB	FINE SEC SO4

TABLE C-3 (CONTINUED)

19	31	.000000	.000000	SE	FINE SEC SO4
19	21	.000000	.000000	SI	FINE SEC SO4
19	22	.000000	.000000	SN	FINE SEC SO4
19	19	1.000000	.000000	SO4	FINE SEC SO4
19	23	.000000	.000000	SR	FINE SEC SO4
19	24	.000000	.000000	TI	FINE SEC SO4
19	25	.000000	.000000	V	FINE SEC SO4
19	26	.000000	.000000	ZN	FINE SEC SO4

TABLE C-4. COARSE FRACTION SOURCE SIGNATURE INPUT FILE

```
1   2   .005500   .001375   AL    COARSE SOIL
1   3   .000000   .000000   AS    COARSE SOIL
1   4   .000000   .000000   BA    COARSE SOIL
1   5   .000000   .000000   BR    COARSE SOIL
1  27   .000000   .000000   C     COARSE SOIL
1   6   .051000   .012750   CA    COARSE SOIL
1   7   .000000   .000000   CD    COARSE SOIL
1   8   .000000   .000000   CL    COARSE SOIL
1  10   .000000   .000000   CR    COARSE SOIL
1  11   .000090   .000022   CU    COARSE SOIL
1  12   .004800   .001200   FE    COARSE SOIL
1  14   .001200   .000300   K     COARSE SOIL
1  15   .000210   .000053   MN    COARSE SOIL
1  28   .000000   .000000   NA    COARSE SOIL
1  16   .000000   .000000   NI    COARSE SOIL
1  29   .000000   .000000   NO3   COARSE SOIL
1  18   .000200   .000050   PB    COARSE SOIL
1  30   .000020   .000005   RB    COARSE SOIL
1  20   .000000   .000000   SB    COARSE SOIL
1  31   .000000   .000000   SE    COARSE SOIL
1  21   .024000   .006000   SI    COARSE SOIL
1  22   .000000   .000000   SN    COARSE SOIL
1  19   .002700   .000675   SO4   COARSE SOIL
1  23   .000140   .000035   SR    COARSE SOIL
1  24   .000890   .000223   TI    COARSE SOIL
1  25   .000000   .000000   V     COARSE SOIL
1  26   .000090   .000022   ZN    COARSE SOIL
2   2   .065900   .016475   AL    COARSE RD DUST
2   3   .000000   .000000   AS    COARSE RD DUST
2   4   .000000   .000000   BA    COARSE RD DUST
2   5   .000080   .000020   BR    COARSE RD DUST
2  27   .048900   .012225   C     COARSE RD DUST
2   6   .030000   .007500   CA    COARSE RD DUST
2   7   .000000   .000000   CD    COARSE RD DUST
2   8   .000000   .000000   CL    COARSE RD DUST
2  10   .000000   .000000   CR    COARSE RD DUST
2  11   .000000   .000000   CU    COARSE RD DUST
2  12   .057300   .014325   FE    COARSE RD DUST
2  14   .000000   .000000   K     COARSE RD DUST
2  15   .001000   .000250   MN    COARSE RD DUST
2  28   .017500   .004375   NA    COARSE RD DUST
2  16   .000000   .000000   NI    COARSE RD DUST
2  29   .000200   .000050   NO3   COARSE RD DUST
2  18   .000000   .000000   PB    COARSE RD DUST
```

TABLE C-4 (CONTINUED)

2	30	.000000	.000000	RB	COARSE RD DUST
2	20	.000000	.000000	SB	COARSE RD DUST
2	31	.000000	.000000	SE	COARSE RD DUST
2	21	.284000	.071000	SI	COARSE RD DUST
2	22	.000000	.000000	SN	COARSE RD DUST
2	19	.000000	.000000	SO4	COARSE RD DUST
2	23	.000000	.000000	SR	COARSE RD DUST
2	24	.010100	.002525	TI	COARSE RD DUST
2	25	.000270	.000068	V	COARSE RD DUST
2	26	.000000	.000000	ZN	COARSE RD DUST
3	2	.000000	.000000	AL	COARSE SEA SALT
3	3	.000000	.000000	AS	COARSE SEA SALT
3	4	.000000	.000000	BA	COARSE SEA SALT
3	5	.000000	.000000	BR	COARSE SEA SALT
3	27	.000000	.000000	C	COARSE SEA SALT
3	6	.010000	.002500	CA	COARSE SEA SALT
3	7	.000000	.000000	CD	COARSE SEA SALT
3	8	.550000	.137500	CL	COARSE SEA SALT
3	10	.000000	.000000	CR	COARSE SEA SALT
3	11	.000000	.000000	CU	COARSE SEA SALT
3	12	.000000	.000000	FE	COARSE SEA SALT
3	14	.010000	.002500	K	COARSE SEA SALT
3	15	.000000	.000000	MN	COARSE SEA SALT
3	28	.310000	.077500	NA	COARSE SEA SALT
3	16	.000000	.000000	NI	COARSE SEA SALT
3	29	.000000	.000000	NO3	COARSE SEA SALT
3	18	.000000	.000000	PB	COARSE SEA SALT
3	30	.000000	.000000	RB	COARSE SEA SALT
3	20	.000000	.000000	SB	COARSE SEA SALT
3	31	.000000	.000000	SE	COARSE SEA SALT
3	21	.000000	.000000	SI	COARSE SEA SALT
3	22	.000000	.000000	SN	COARSE SEA SALT
3	19	.090000	.022500	SO4	COARSE SEA SALT
3	23	.000000	.000000	SR	COARSE SEA SALT
3	24	.000000	.000000	TI	COARSE SEA SALT
3	25	.000000	.000000	V	COARSE SEA SALT
3	26	.000000	.000000	ZN	COARSE SEA SALT
4	2	.002300	.000575	AL	COARSE SLASH BURN
4	3	.000000	.000000	AS	COARSE SLASH BURN
4	4	.000000	.000000	BA	COARSE SLASH BURN
4	5	.000000	.000000	BR	COARSE SLASH BURN
4	27	.523000	.130750	C	COARSE SLASH BURN
4	6	.001300	.000325	CA	COARSE SLASH BURN
4	7	.000000	.000000	CD	COARSE SLASH BURN
4	8	.009300	.002325	CL	COARSE SLASH BURN

TABLE C-4 (CONTINUED)

4	10	.000000	.000000	CR	COARSE SLASH BURN
4	11	.000000	.000000	CU	COARSE SLASH BURN
4	12	.000000	.000000	FE	COARSE SLASH BURN
4	14	.000000	.000000	K	COARSE SLASH BURN
4	15	.000090	.000022	MN	COARSE SLASH BURN
4	28	.001600	.000400	NA	COARSE SLASH BURN
4	16	.000000	.000000	NI	COARSE SLASH BURN
4	29	.010000	.002500	NO3	COARSE SLASH BURN
4	18	.000000	.000000	PB	COARSE SLASH BURN
4	30	.000000	.000000	RB	COARSE SLASH BURN
4	20	.000000	.000000	SB	COARSE SLASH BURN
4	31	.000000	.000000	SE	COARSE SLASH BURN
4	21	.054000	.013500	SI	COARSE SLASH BURN
4	22	.000000	.000000	SN	COARSE SLASH BURN
4	19	.007500	.001875	SO4	COARSE SLASH BURN
4	23	.000000	.000000	SR	COARSE SLASH BURN
4	24	.000000	.000000	TI	COARSE SLASH BURN
4	25	.000000	.000000	V	COARSE SLASH BURN
4	26	.000000	.000000	ZN	COARSE SLASH BURN
5	2	.001200	.000300	AL	COARSE AUTO W CAT
5	3	.000000	.000000	AS	COARSE AUTO W CAT
5	4	.000000	.000000	BA	COARSE AUTO W CAT
5	5	.000000	.000000	BR	COARSE AUTO W CAT
5	27	.390000	.097500	C	COARSE AUTO W CAT
5	6	.001700	.000425	CA	COARSE AUTO W CAT
5	7	.000000	.000000	CD	COARSE AUTO W CAT
5	8	.000000	.000000	CL	COARSE AUTO W CAT
5	10	.000000	.000000	CR	COARSE AUTO W CAT
5	11	.000240	.000060	CU	COARSE AUTO W CAT
5	12	.001100	.000275	FE	COARSE AUTO W CAT
5	14	.000440	.000110	K	COARSE AUTO W CAT
5	15	.000150	.000037	MN	COARSE AUTO W CAT
5	28	.000000	.000000	NA	COARSE AUTO W CAT
5	16	.000150	.000037	NI	COARSE AUTO W CAT
5	29	.000000	.000000	NO3	COARSE AUTO W CAT
5	18	.000000	.000000	PB	COARSE AUTO W CAT
5	30	.000000	.000000	RB	COARSE AUTO W CAT
5	20	.000000	.000000	SB	COARSE AUTO W CAT
5	31	.000000	.000000	SE	COARSE AUTO W CAT
5	21	.005100	.001275	SI	COARSE AUTO W CAT
5	22	.000000	.000000	SN	COARSE AUTO W CAT
5	19	.500000	.125000	SO4	COARSE AUTO W CAT
5	23	.000000	.000000	SR	COARSE AUTO W CAT
5	24	.000000	.000000	TI	COARSE AUTO W CAT
5	25	.000000	.000000	V	COARSE AUTO W CAT
5	26	.000800	.000200	ZN	COARSE AUTO W CAT

TABLE C-4 (CONTINUED)

6	2	.000430	.000108	AL	COARSE AUTO
6	3	.000000	.000000	AS	COARSE AUTO
6	4	.000000	.000000	BA	COARSE AUTO
6	5	.082000	.020500	BR	COARSE AUTO
6	27	.545000	.136250	C	COARSE AUTO
6	6	.000000	.000000	CA	COARSE AUTO
6	7	.000000	.000000	CD	COARSE AUTO
6	8	.054000	.013500	CL	COARSE AUTO
6	10	.000000	.000000	CR	COARSE AUTO
6	11	.000040	.000010	CU	COARSE AUTO
6	12	.002500	.000625	FE	COARSE AUTO
6	14	.000000	.000000	K	COARSE AUTO
6	15	.000000	.000000	MN	COARSE AUTO
6	28	.000000	.000000	NA	COARSE AUTO
6	16	.000000	.000000	NI	COARSE AUTO
6	29	.000000	.000000	NO3	COARSE AUTO
6	18	.211000	.052750	PB	COARSE AUTO
6	30	.000000	.000000	RB	COARSE AUTO
6	20	.000000	.000000	SB	COARSE AUTO
6	31	.000000	.000000	SE	COARSE AUTO
6	21	.000750	.000187	SI	COARSE AUTO
6	22	.000000	.000000	SN	COARSE AUTO
6	19	.002100	.000525	SO4	COARSE AUTO
6	23	.000000	.000000	SR	COARSE AUTO
6	24	.000000	.000000	TI	COARSE AUTO
6	25	.000000	.000000	V	COARSE AUTO
6	26	.000210	.000053	ZN	COARSE AUTO
7	2	.000000	.000000	AL	COARSE JET AIR
7	3	.000000	.000000	AS	COARSE JET AIR
7	4	.000000	.000000	BA	COARSE JET AIR
7	5	.000000	.000000	BR	COARSE JET AIR
7	27	.960000	.240000	C	COARSE JET AIR
7	6	.000000	.000000	CA	COARSE JET AIR
7	7	.000000	.000000	CD	COARSE JET AIR
7	8	.000000	.000000	CL	COARSE JET AIR
7	10	.000000	.000000	CR	COARSE JET AIR
7	11	.000000	.000000	CU	COARSE JET AIR
7	12	.000000	.000000	FE	COARSE JET AIR
7	14	.000000	.000000	K	COARSE JET AIR
7	15	.000000	.000000	MN	COARSE JET AIR
7	28	.000000	.000000	NA	COARSE JET AIR
7	16	.000000	.000000	NI	COARSE JET AIR
7	29	.000000	.000000	NO3	COARSE JET AIR
7	18	.000000	.000000	PB	COARSE JET AIR
7	30	.000000	.000000	RB	COARSE JET AIR
7	20	.000000	.000000	SB	COARSE JET AIR

TABLE C-4 (CONTINUED)

7	31	.000000	.000000	SE	COARSE JET AIR
7	21	.000000	.000000	SI	COARSE JET AIR
7	22	.000000	.000000	SN	COARSE JET AIR
7	19	.000000	.000000	SO4	COARSE JET AIR
7	23	.000000	.000000	SR	COARSE JET AIR
7	24	.000000	.000000	TI	COARSE JET AIR
7	25	.000000	.000000	V	COARSE JET AIR
7	26	.000000	.000000	ZN	COARSE JET AIR
8	2	.014700	.003675	AL	COARSE RESIDUAL OIL
8	3	.000000	.000000	AS	COARSE RESIDUAL OIL
8	4	.000000	.000000	BA	COARSE RESIDUAL OIL
8	5	.000000	.000000	BR	COARSE RESIDUAL OIL
8	27	.315000	.078750	C	COARSE RESIDUAL OIL
8	6	.035600	.008900	CA	COARSE RESIDUAL OIL
8	7	.000000	.000000	CD	COARSE RESIDUAL OIL
8	8	.007400	.001850	CL	COARSE RESIDUAL OIL
8	10	.000540	.000135	CR	COARSE RESIDUAL OIL
8	11	.000860	.000215	CU	COARSE RESIDUAL OIL
8	12	.014700	.003675	FE	COARSE RESIDUAL OIL
8	14	.000000	.000000	K	COARSE RESIDUAL OIL
8	15	.000270	.000068	MN	COARSE RESIDUAL OIL
8	28	.009000	.002250	NA	COARSE RESIDUAL OIL
8	16	.013900	.003475	NI	COARSE RESIDUAL OIL
8	29	.000000	.000000	NO3	COARSE RESIDUAL OIL
8	18	.000000	.000000	PB	COARSE RESIDUAL OIL
8	30	.000000	.000000	RB	COARSE RESIDUAL OIL
8	20	.000000	.000000	SB	COARSE RESIDUAL OIL
8	31	.000000	.000000	SE	COARSE RESIDUAL OIL
8	21	.037000	.009250	SI	COARSE RESIDUAL OIL
8	22	.000000	.000000	SN	COARSE RESIDUAL OIL
8	19	.073000	.018250	SO4	COARSE RESIDUAL OIL
8	23	.000000	.000000	SR	COARSE RESIDUAL OIL
8	24	.001400	.000350	TI	COARSE RESIDUAL OIL
8	25	.017900	.004475	V	COARSE RESIDUAL OIL
8	26	.000500	.000125	ZN	COARSE RESIDUAL OIL
9	2	.005900	.001475	AL	COARSE DISTILLATE OIL
9	3	.000000	.000000	AS	COARSE DISTILLATE OIL
9	4	.000000	.000000	BA	COARSE DISTILLATE OIL
9	5	.000000	.000000	BR	COARSE DISTILLATE OIL
9	27	.172000	.043000	C	COARSE DISTILLATE OIL
9	6	.005000	.001250	CA	COARSE DISTILLATE OIL
9	7	.000000	.000000	CD	COARSE DISTILLATE OIL
9	8	.016000	.004000	CL	COARSE DISTILLATE OIL
9	10	.000000	.000000	CR	COARSE DISTILLATE OIL
9	11	.001100	.000275	CU	COARSE DISTILLATE OIL
9	12	.002300	.000575	FE	COARSE DISTILLATE OIL

TABLE C-4 (CONTINUED)

9	14	.000000	.000000	K	COARSE DISTILLATE OIL
9	15	.000130	.000033	MN	COARSE DISTILLATE OIL
9	28	.006900	.001725	NA	COARSE DISTILLATE OIL
9	16	.000000	.000000	NI	COARSE DISTILLATE OIL
9	29	.000000	.000000	NO3	COARSE DISTILLATE OIL
9	18	.000000	.000000	PB	COARSE DISTILLATE OIL
9	30	.000000	.000000	RB	COARSE DISTILLATE OIL
9	20	.000000	.000000	SB	COARSE DISTILLATE OIL
9	31	.000000	.000000	SE	COARSE DISTILLATE OIL
9	21	.002900	.000725	SI	COARSE DISTILLATE OIL
9	22	.000000	.000000	SN	COARSE DISTILLATE OIL
9	19	.000000	.000000	SO4	COARSE DISTILLATE OIL
9	23	.000000	.000000	SR	COARSE DISTILLATE OIL
9	24	.000000	.000000	TI	COARSE DISTILLATE OIL
9	25	.000000	.000000	V	COARSE DISTILLATE OIL
9	26	.000000	.000000	ZN	COARSE DISTILLATE OIL
10	2	.000000	.000000	AL	COARSE RESIDENTIAL GAS
10	3	.000000	.000000	AS	COARSE RESIDENTIAL GAS
10	4	.000000	.000000	BA	COARSE RESIDENTIAL GAS
10	5	.000000	.000000	BR	COARSE RESIDENTIAL GAS
10	27	.120000	.030000	C	COARSE RESIDENTIAL GAS
10	6	.050000	.012500	CA	COARSE RESIDENTIAL GAS
10	7	.000000	.000000	CD	COARSE RESIDENTIAL GAS
10	8	.000000	.000000	CL	COARSE RESIDENTIAL GAS
10	10	.000000	.000000	CR	COARSE RESIDENTIAL GAS
10	11	.000000	.000000	CU	COARSE RESIDENTIAL GAS
10	12	.000000	.000000	FE	COARSE RESIDENTIAL GAS
10	14	.000000	.000000	K	COARSE RESIDENTIAL GAS
10	15	.000000	.000000	MN	COARSE RESIDENTIAL GAS
10	28	.000000	.000000	NA	COARSE RESIDENTIAL GAS
10	16	.000000	.000000	NI	COARSE RESIDENTIAL GAS
10	29	.000000	.000000	NO3	COARSE RESIDENTIAL GAS
10	18	.000000	.000000	PB	COARSE RESIDENTIAL GAS
10	30	.000000	.000000	RB	COARSE RESIDENTIAL GAS
10	20	.000000	.000000	SB	COARSE RESIDENTIAL GAS
10	31	.000000	.000000	SE	COARSE RESIDENTIAL GAS
10	21	.000000	.000000	SI	COARSE RESIDENTIAL GAS
10	22	.000000	.000000	SN	COARSE RESIDENTIAL GAS
10	19	.470000	.117500	SO4	COARSE RESIDENTIAL GAS
10	23	.000000	.000000	SR	COARSE RESIDENTIAL GAS
10	24	.000000	.000000	TI	COARSE RESIDENTIAL GAS
10	25	.000000	.000000	V	COARSE RESIDENTIAL GAS
10	26	.000000	.000000	ZN	COARSE RESIDENTIAL GAS

TABLE C-4 (CONTINUED)

11	2	.000000	.000000	AL	COARSE COAL
11	3	.000000	.000000	AS	COARSE COAL
11	4	.000000	.000000	BA	COARSE COAL
11	5	.000000	.000000	BR	COARSE COAL
11	27	.000000	.000000	C	COARSE COAL
11	6	.023600	.005900	CA	COARSE COAL
11	7	.000000	.000000	CD	COARSE COAL
11	8	.000000	.000000	CL	COARSE COAL
11	10	.000000	.000000	CR	COARSE COAL
11	11	.000000	.000000	CU	COARSE COAL
11	12	.040990	.010248	FE	COARSE COAL
11	14	.000000	.000000	K	COARSE COAL
11	15	.000000	.000000	MN	COARSE COAL
11	28	.000000	.000000	NA	COARSE COAL
11	16	.000000	.000000	NI	COARSE COAL
11	29	.000000	.000000	NO3	COARSE COAL
11	18	.000000	.000000	PB	COARSE COAL
11	30	.000000	.000000	RB	COARSE COAL
11	20	.000000	.000000	SB	COARSE COAL
11	31	.000000	.000000	SE	COARSE COAL
11	21	.032920	.008230	SI	COARSE COAL
11	22	.000000	.000000	SN	COARSE COAL
11	19	.121120	.030280	SO4	COARSE COAL
11	23	.000000	.000000	SR	COARSE COAL
11	24	.000000	.000000	TI	COARSE COAL
11	25	.000000	.000000	V	COARSE COAL
11	26	.006830	.001708	ZN	COARSE COAL
12	2	.002800	.000700	AL	COARSE KRAFT REC BOILER
12	3	.000000	.000000	AS	COARSE KRAFT REC BOILER
12	4	.000000	.000000	BA	COARSE KRAFT REC BOILER
12	5	.000560	.000140	BR	COARSE KRAFT REC BOILER
12	27	.176000	.044000	C	COARSE KRAFT REC BOILER
12	6	.003600	.000900	CA	COARSE KRAFT REC BOILER
12	7	.000000	.000000	CD	COARSE KRAFT REC BOILER
12	8	.029000	.007250	CL	COARSE KRAFT REC BOILER
12	10	.004800	.001200	CR	COARSE KRAFT REC BOILER
12	11	.000600	.000150	CU	COARSE KRAFT REC BOILER
12	12	.018400	.004600	FE	COARSE KRAFT REC BOILER
12	14	.004000	.001000	K	COARSE KRAFT REC BOILER
12	15	.000520	.000130	MN	COARSE KRAFT REC BOILER
12	28	.053000	.013250	NA	COARSE KRAFT REC BOILER
12	16	.002200	.000550	NI	COARSE KRAFT REC BOILER
12	29	.000000	.000000	NO3	COARSE KRAFT REC BOILER
12	18	.000000	.000000	PB	COARSE KRAFT REC BOILER

TABLE C-4 (CONTINUED)

12	30	.000000	.000000	RB	COARSE KRAFT REC BOILER
12	20	.000000	.000000	SB	COARSE KRAFT REC BOILER
12	31	.000000	.000000	SE	COARSE KRAFT REC BOILER
12	21	.001300	.000325	SI	COARSE KRAFT REC BOILER
12	22	.000000	.000000	SN	COARSE KRAFT REC BOILER
12	19	.118000	.029500	SO4	COARSE KRAFT REC BOILER
12	23	.000000	.000000	SR	COARSE KRAFT REC BOILER
12	24	.000000	.000000	TI	COARSE KRAFT REC BOILER
12	25	.000000	.000000	V	COARSE KRAFT REC BOILER
12	26	.000000	.000000	ZN	COARSE KRAFT REC BOILER
13	2	.000000	.000000	AL	COARSE ELEC ARC FURN
13	3	.000000	.000000	AS	COARSE ELEC ARC FURN
13	4	.000000	.000000	BA	COARSE ELEC ARC FURN
13	5	.000000	.000000	BR	COARSE ELEC ARC FURN
13	27	.000000	.000000	C	COARSE ELEC ARC FURN
13	6	.069000	.017250	CA	COARSE ELEC ARC FURN
13	7	.000000	.000000	CD	COARSE ELEC ARC FURN
13	8	.038000	.009500	CL	COARSE ELEC ARC FURN
13	10	.021000	.005250	CR	COARSE ELEC ARC FURN
13	11	.004300	.001075	CU	COARSE ELEC ARC FURN
13	12	.308000	.077000	FE	COARSE ELEC ARC FURN
13	14	.005600	.001400	K	COARSE ELEC ARC FURN
13	15	.095000	.023750	MN	COARSE ELEC ARC FURN
13	28	.014000	.003500	NA	COARSE ELEC ARC FURN
13	16	.006200	.001550	NI	COARSE ELEC ARC FURN
13	29	.000000	.000000	NO3	COARSE ELEC ARC FURN
13	18	.006400	.001600	PB	COARSE ELEC ARC FURN
13	30	.000000	.000000	RB	COARSE ELEC ARC FURN
13	20	.000000	.000000	SB	COARSE ELEC ARC FURN
13	31	.000000	.000000	SE	COARSE ELEC ARC FURN
13	21	.066000	.016500	SI	COARSE ELEC ARC FURN
13	22	.000000	.000000	SN	COARSE ELEC ARC FURN
13	19	.013000	.003250	SO4	COARSE ELEC ARC FURN
13	23	.000000	.000000	SR	COARSE ELEC ARC FURN
13	24	.001100	.000275	TI	COARSE ELEC ARC FURN
13	25	.000580	.000145	V	COARSE ELEC ARC FURN
13	26	.012000	.003000	ZN	COARSE ELEC ARC FURN
14	2	.001800	.000450	AL	COARSE FERROMANGANESE FURN
14	3	.000000	.000000	AS	COARSE FERROMANGANESE FURN
14	4	.000000	.000000	BA	COARSE FERROMANGANESE FURN
14	5	.000000	.000000	BR	COARSE FERROMANGANESE FURN
14	27	.190000	.047500	C	COARSE FERROMANGANESE FURN
14	6	.005700	.001425	CA	COARSE FERROMANGANESE FURN
14	7	.000000	.000000	CD	COARSE FERROMANGANESE FURN
14	8	.008500	.002125	CL	COARSE FERROMANGANESE FURN
14	10	.000230	.000057	CR	COARSE FERROMANGANESE FURN
14	11	.000740	.000185	CU	COARSE FERROMANGANESE FURN

TABLE C-4 (CONTINUED)

14	12	.003800	.000950	FE	COARSE FERROMANGANESE FURN
14	14	.012000	.003000	K	COARSE FERROMANGANESE FURN
14	15	.027500	.006875	MN	COARSE FERROMANGANESE FURN
14	28	.003400	.000850	NA	COARSE FERROMANGANESE FURN
14	16	.000000	.000000	NI	COARSE FERROMANGANESE FURN
14	29	.012000	.003000	NO3	COARSE FERROMANGANESE FURN
14	18	.000000	.000000	PB	COARSE FERROMANGANESE FURN
14	30	.000000	.000000	RB	COARSE FERROMANGANESE FURN
14	20	.000000	.000000	SB	COARSE FERROMANGANESE FURN
14	31	.000000	.000000	SE	COARSE FERROMANGANESE FURN
14	21	.002900	.000725	SI	COARSE FERROMANGANESE FURN
14	22	.000000	.000000	SN	COARSE FERROMANGANESE FURN
14	19	.011000	.002750	SO4	COARSE FERROMANGANESE FURN
14	23	.000000	.000000	SR	COARSE FERROMANGANESE FURN
14	24	.000000	.000000	TI	COARSE FERROMANGANESE FURN
14	25	.000090	.000022	V	COARSE FERROMANGANESE FURN
14	26	.000350	.000087	ZN	COARSE FERROMANGANESE FURN
15	2	.000000	.000000	AL	COARSE CALCINATION OF GYPSUM
15	3	.000000	.000000	AS	COARSE CALCINATION OF GYPSUM
15	4	.000000	.000000	BA	COARSE CALCINATION OF GYPSUM
15	5	.000000	.000000	BR	COARSE CALCINATION OF GYPSUM
15	27	.000000	.000000	C	COARSE CALCINATION OF GYPSUM
15	6	.090000	.022500	CA	COARSE CALCINATION OF GYPSUM
15	7	.000000	.000000	CD	COARSE CALCINATION OF GYPSUM
15	8	.000000	.000000	CL	COARSE CALCINATION OF GYPSUM
15	10	.000000	.000000	CR	COARSE CALCINATION OF GYPSUM
15	11	.000000	.000000	CU	COARSE CALCINATION OF GYPSUM
15	12	.000000	.000000	FE	COARSE CALCINATION OF GYPSUM
15	14	.000000	.000000	K	COARSE CALCINATION OF GYPSUM
15	15	.000000	.000000	MN	COARSE CALCINATION OF GYPSUM
15	28	.000000	.000000	NA	COARSE CALCINATION OF GYPSUM
15	16	.000000	.000000	NI	COARSE CALCINATION OF GYPSUM
15	29	.000000	.000000	NO3	COARSE CALCINATION OF GYPSUM
15	18	.000000	.000000	PB	COARSE CALCINATION OF GYPSUM
15	30	.000000	.000000	RB	COARSE CALCINATION OF GYPSUM
15	20	.000000	.000000	SB	COARSE CALCINATION OF GYPSUM
15	31	.000000	.000000	SE	COARSE CALCINATION OF GYPSUM
15	21	.000000	.000000	SI	COARSE CALCINATION OF GYPSUM
15	22	.000000	.000000	SN	COARSE CALCINATION OF GYPSUM
15	19	.570000	.142500	SO4	COARSE CALCINATION OF GYPSUM
15	23	.000000	.000000	SR	COARSE CALCINATION OF GYPSUM
15	24	.000000	.000000	TI	COARSE CALCINATION OF GYPSUM
15	25	.000000	.000000	V	COARSE CALCINATION OF GYPSUM
15	26	.000000	.000000	ZN	COARSE CALCINATION OF GYPSUM
16	2	.000000	.000000	AL	COARSE CEMENT
16	3	.000000	.000000	AS	COARSE CEMENT

TABLE C-4 (CONTINUED)

16	4	.000000	.000000	BA	COARSE CEMENT
16	5	.000000	.000000	BR	COARSE CEMENT
16	27	.190000	.047500	C	COARSE CEMENT
16	6	.200000	.050000	CA	COARSE CEMENT
16	7	.000000	.000000	CD	COARSE CEMENT
16	8	.000000	.000000	CL	COARSE CEMENT
16	10	.000000	.000000	CR	COARSE CEMENT
16	11	.000000	.000000	CU	COARSE CEMENT
16	12	.000000	.000000	FE	COARSE CEMENT
16	14	.020000	.005000	K	COARSE CEMENT
16	15	.000000	.000000	MN	COARSE CEMENT
16	28	.000000	.000000	NA	COARSE CEMENT
16	16	.000000	.000000	NI	COARSE CEMENT
16	29	.000000	.000000	NO3	COARSE CEMENT
16	18	.000000	.000000	PB	COARSE CEMENT
16	30	.000000	.000000	RB	COARSE CEMENT
16	20	.000000	.000000	SB	COARSE CEMENT
16	31	.000000	.000000	SE	COARSE CEMENT
16	21	.100000	.025000	SI	COARSE CEMENT
16	22	.000000	.000000	SN	COARSE CEMENT
16	19	.030000	.007500	SO4	COARSE CEMENT
16	23	.000000	.000000	SR	COARSE CEMENT
16	24	.000000	.000000	TI	COARSE CEMENT
16	25	.000000	.000000	V	COARSE CEMENT
16	26	.000000	.000000	ZN	COARSE CEMENT
17	2	.000000	.000000	AL	PETROL-FCC UNDTS
17	3	.000000	.000000	AS	PETROL-FCC UNDTS
17	4	.000000	.000000	BA	PETROL-FCC UNDTS
17	5	.000000	.000000	BR	PETROL-FCC UNDTS
17	27	.000000	.000000	C	PETROL-FCC UNDTS
17	6	.000000	.000000	CA	PETROL-FCC UNDTS
17	7	.000000	.000000	CD	PETROL-FCC UNDTS
17	8	.000000	.000000	CL	PETROL-FCC UNDTS
17	10	.000000	.000000	CR	PETROL-FCC UNDTS
17	11	.000000	.000000	CU	PETROL-FCC UNDTS
17	12	.005000	.001250	FE	PETROL-FCC UNDTS
17	14	.000000	.000000	K	PETROL-FCC UNDTS
17	15	.000000	.000000	MN	PETROL-FCC UNDTS
17	28	.000000	.000000	NA	PETROL-FCC UNDTS
17	16	.000000	.000000	NI	PETROL-FCC UNDTS
17	29	.000000	.000000	NO3	PETROL-FCC UNDTS
17	18	.000000	.000000	PB	PETROL-FCC UNDTS
17	30	.000000	.000000	RB	PETROL-FCC UNDTS
17	20	.000000	.000000	SB	PETROL-FCC UNDTS
17	31	.000000	.000000	SE	PETROL-FCC UNDTS
17	21	.200000	.050000	SI	PETROL-FCC UNDTS

TABLE C-4 (CONTINUED)

17	22	.000000	.000000	SN	PETROL-FCC UNDTS
17	19	.070000	.017500	SO4	PETROL-FCC UNDTS
17	23	.000000	.000000	SR	PETROL-FCC UNDTS
17	24	.000000	.000000	TI	PETROL-FCC UNDTS
17	25	.000000	.000000	V	PETROL-FCC UNDTS
17	26	.000000	.000000	ZN	PETROL-FCC UNDTS
18	2	.000000	.000000	AL	COARSE LS KILN
18	3	.000000	.000000	AS	COARSE LS KILN
18	4	.000000	.000000	BA	COARSE LS KILN
18	5	.000000	.000000	BR	COARSE LS KILN
18	27	.400000	.100000	C	COARSE LS KILN
18	6	.300000	.075000	CA	COARSE LS KILN
18	7	.000000	.000000	CD	COARSE LS KILN
18	8	.000000	.000000	CL	COARSE LS KILN
18	10	.000000	.000000	CR	COARSE LS KILN
18	11	.000000	.000000	CU	COARSE LS KILN
18	12	.020000	.005000	FE	COARSE LS KILN
18	14	.000000	.000000	K	COARSE LS KILN
18	15	.000000	.000000	MN	COARSE LS KILN
18	28	.000000	.000000	NA	COARSE LS KILN
18	16	.000000	.000000	NI	COARSE LS KILN
18	29	.000000	.000000	NO3	COARSE LS KILN
18	18	.000000	.000000	PB	COARSE LS KILN
18	30	.000000	.000000	RB	COARSE LS KILN
18	20	.000000	.000000	SB	COARSE LS KILN
18	31	.100000	.025000	SE	COARSE LS KILN
18	21	.000000	.000000	SI	COARSE LS KILN
18	22	.000000	.000000	SN	COARSE LS KILN
18	19	.000000	.000000	SO4	COARSE LS KILN
18	23	.000000	.000000	SR	COARSE LS KILN
18	24	.000000	.000000	TI	COARSE LS KILN
18	25	.000000	.000000	V	COARSE LS KILN
18	26	.000000	.000000	ZN	COARSE LS KILN
19	2	.000000	.000000	AL	COARSE SECONDARY SO4
19	3	.000000	.000000	AS	COARSE SECONDARY SO4
19	4	.000000	.000000	BA	COARSE SECONDARY SO4
19	5	.000000	.000000	BR	COARSE SECONDARY SO4
19	27	.000000	.000000	C	COARSE SECONDARY SO4
19	6	.000000	.000000	CA	COARSE SECONDARY SO4
19	7	.000000	.000000	CD	COARSE SECONDARY SO4
19	8	.000000	.000000	CL	COARSE SECONDARY SO4
19	10	.000000	.000000	CR	COARSE SECONDARY SO4
19	11	.000000	.000000	CU	COARSE SECONDARY SO4
19	12	.000000	.000000	FE	COARSE SECONDARY SO4
19	14	.000000	.000000	K	COARSE SECONDARY SO4
19	15	.000000	.000000	MN	COARSE SECONDARY SO4
19	28	.000000	.000000	NA	COARSE SECONDARY SO4

TABLE C-4 (CONTINUED)

19	16	.000000	.000000	NI	COARSE SECONDARY SO4
19	29	.000000	.000000	NO3	COARSE SECONDARY SO4
19	18	.000000	.000000	PB	COARSE SECONDARY SO4
19	30	.000000	.000000	RB	COARSE SECONDARY SO4
19	20	.000000	.000000	SB	COARSE SECONDARY SO4
19	31	.000000	.000000	SE	COARSE SECONDARY SO4
19	21	.000000	.000000	SI	COARSE SECONDARY SO4
19	22	.000000	.000000	SN	COARSE SECONDARY SO4
19	19	1.000000	.000000	SO4	COARSE SECONDARY SO4
19	23	.000000	.000000	SR	COARSE SECONDARY SO4
19	24	.000000	.000000	TI	COARSE SECONDARY SO4
19	25	.000000	.000000	V	COARSE SECONDARY SO4
19	26	.000000	.000000	ZN	COARSE SECONDARY SO4

TABLE C-5. RECEPTOR CONCENTRATION INPUT FILE

```
03 URBAN CORE    810229 12 07     12
30                                 1  35.        7.        75.       7.
30                                 2  .088       .062      1.951     .422
30                                 3  .036       .007      .004      .004
30                                 4  .149       .014      .371      .023
30                                 5  .344       .017      .108      .007
30                                 6  .441       .023      13.014    1.442
30                                 7  .004       .002      .0005     .001
30                                 8  .051       .007      .288      .068
30                                 9  .003       .002      .015      .003
30                                10  .002       .004      .022      .005
30                                11  .013       .002      .018      .002
30                                12  .208       .011      1.871     .118
30                                13  0.         .003      .001      .002
30                                14  .165       .009      .517      .072
30                                15  .022       .004      .088      .008
30                                16  .006       .001      .003      .001
30                                17  .119       .017      .102      .040
30                                18  1.422      .068      .346      .024
30                                19  13.13      .681      1.725     .939
30                                20  .003       .002      .004      .002
30                                21  .277       .031      8.652     1.987
30                                22  .001       .002      .005      .002
30                                23  .003       .001      .030      .003
30                                24  .007       .014      .205      .037
30                                25  .002       .008      .007      .014
30                                26  .042       .003      .071      .006
03 BACKGROUND    810229 12 07     12
30                                 1  28.        3.        37.       4.
30                                 2  .070       .055      .739      .171
30                                 3  .014       .006      .001      .004
30                                 4  .146       .018      .086      .016
30                                 5  .164       .010      .064      .005
30                                 6  .128       .008      3.805     .444
30                                 7  .001       .002      .001      .002
30                                 8  .010       .007      .014      .010
30                                 9  .008       .003      .001      .003
30                                10  .010       .005      .0025     .005
30                                11  .027       .003      .004      .002
30                                12  .120       .008      .692      .044
30                                13  .0015      .003      .009      .003
30                                14  .186       .010      .215      .032
30                                15  .022       .004      .018      .004
30                                16  .003       .002      .001      .002
```

TABLE C-5 (CONTINUED)

30	17	.103	.018	.020	.022
30	18	.894	.047	.213	.017
30	19	14.78	.765	.852	.783
30	20	.008	.003	.001	.003
30	21	.189	.027	4.0	.914
30	22	.024	.003	.003	.003
30	23	.003	.002	.006	.002
30	24	.008	.016	.097	.017
30	25	.003	.009	.0035	.007
30	26	.038	.003	.016	.003

TABLE C-6. SUMMARY HARDCOPY OUTPUT FILE

```
                          *** CMB SOURCE CONTRIBUTION SUMMARY ***

                        RESULTS FOR CMB SITE: URBAN CORE       YEAR: 81   DATE: 0229
                     SAMPLING DURATION: 12 HRS. WITH START HOUR:  7
                    BACKGROUND SITE SUBTRACTED: NO

 SOURCE                    FINE                                COARSE                               TOTAL
-------------------------------------------------------------------------------------------------------------------------
                UG/M3               %                 UG/M3               %                 UG/M3               %
INTERCEPT    .004 +-   .004                        .011 +-   .005                        .015 +-   .006
SOIL        -.509 +-  3.092    4.419 +-  8.838   36.445 +- 18.752   48.593 +- 25.410   35.936 +- 19.005   32.669 +- 17.525
RD DUST     -.024 +-   .923    1.318 +-  2.636   13.578 +-  6.185   18.104 +-  8.418   13.554 +-  6.254   12.321 +-  5.792
SEA SALT    -.446 +-   .171     .276 +-   .552     .177 +-   .491     .328 +-   .655    -.270 +-   .520     .237 +-   .473
AUTO CAT    7.377 +- 20.436   29.271 +- 58.541   10.339 +- 13.655    9.126 +- 18.252   17.717 +- 24.579   11.196 +- 22.391
AUTO        4.635 +-   .941   13.244 +-  3.773     .722 +-   .275     .963 +-   .378    5.358 +-   .980    4.871 +-   .993
DIST OIL    3.596 +-  6.614    9.505 +- 19.009     .000 +-   .000     .000 +-   .000    3.596 +-  6.614    3.010 +-  6.020
RES GAS     1.015 +-  5.311    7.593 +- 15.186     .000 +-   .000     .000 +-   .000    1.015 +-  5.311    2.415 +-  4.829
COAL        1.771 +-  1.348    5.059 +-  3.981    4.532 +-  3.137    6.043 +-  4.220    6.303 +-  3.414    5.730 +-  3.146
KRAFT RB     .000 +-   .000     .000 +-   .000    2.229 +-  3.455    2.308 +-  4.615    2.229 +-  3.455    1.573 +-  3.146
ELARCFRN     .076 +-   .454     .648 +-  1.296     .000 +-   .000     .000 +-   .000     .076 +-   .454     .206 +-   .412
FERRMNFR     .061 +-   .250     .358 +-   .715     .000 +-   .000     .000 +-   .000     .061 +-   .250     .114 +-   .227
CEMENT      7.403 +-  2.919   21.151 +-  9.353   13.874 +- 11.324   18.499 +- 15.197   21.277 +- 11.694   19.343 +- 10.773
PET FCC     8.221 +- 12.252   17.660 +- 35.320     .000 +-   .000     .000 +-   .000    8.221 +- 12.252    5.579 +- 11.159
SEC SO4     -.187 +- 11.012   15.732 +- 31.464     .000 +-   .000     .000 +-   .000    -.187 +- 11.012    5.006 +- 10.011
-------------------------------------------------------------------------------------------------------------------------
CALC.MASS  32.991 +- 15.162   94.261 +- 47.244   81.908 +- 25.267  109.210 +- 35.197  114.899 +- 29.467  104.454 +-   .001
MEAS.MASS  35.000 +-  7.000                      75.000 +-  7.000                     110.000 +-  9.899
```

TABLE C-6 (CONTINUED)

```
                         *** CMB SOURCE CONTRIBUTION SUMMARY ***

                     RESULTS FOR CMB SITE: BACKGROUND      YEAR: 81   DATE: 0229
                 SAMPLING DURATION: 12 HRS. WITH START HOUR:  7
                BACKGROUND SITE SUBTRACTED: NO
SOURCE                   FINE                          COARSE                           TOTAL
---------------------------------------------------------------------------------------------------------
              UG/M3                %                UG/M3                %              UG/M3                %
INTERCEPT   .006 +-   .006                       .003 +-   .002                    .009 +-   .006
SOIL       -.334 +-   .346    .622 +-  1.243  20.253 +-  5.861  54.738 +- 16.911  19.919 +-  5.872  30.645 +-  9.336
RD DUST     .214 +-   .656   1.171 +-  2.343   6.130 +-  1.363  16.567 +-  4.097   6.343 +-  1.513   9.759 +-  2.445
SEA SALT   -.187 +-   .093    .170 +-   .341   -.024 +-   .031    .042 +-   .084   -.211 +-   .098    .077 +-   .153
AUTO CAT  12.538 +-  7.325  44.778 +- 26.596   1.749 +-  4.822   6.522 +- 13.043  14.287 +-  8.770  21.980 +- 13.597
AUTO       1.889 +-   .609   6.745 +-  2.291    .540 +-   .106   1.460 +-   .327   2.429 +-   .618   3.736 +-   .993
DIST OIL   1.572 +-  3.786   6.768 +- 13.536    .000 +-   .000    .000 +-   .000   1.572 +-  3.786   2.914 +-  5.828
RES GAS    -.735 +-   .733   1.316 +-  2.632    .000 +-   .000    .000 +-   .000   -.735 +-   .733    .565 +-  1.131
COAL       1.088 +-   .951   3.887 +-  3.420   1.397 +-   .840   3.775 +-  2.307   2.485 +-  1.269   3.823 +-  1.974
KRAFT RB    .000 +-   .000    .000 +-   .000    .053 +-   .538    .726 +-  1.453    .053 +-   .538    .413 +-   .827
ELARCFRN   -.053 +-   .114    .204 +-   .408    .000 +-   .000    .000 +-   .000   -.053 +-   .114    .088 +-   .176
FERRMNFR    .147 +-   .137    .523 +-   .492    .000 +-   .000    .000 +-   .000    .147 +-   .137    .225 +-   .211
CEMENT     2.884 +-  1.166  10.300 +-  4.307   6.954 +-  2.694  18.796 +-  7.558   9.838 +-  2.935  15.136 +-  4.663
PET FCC    4.596 +-  4.504  16.416 +- 16.183    .000 +-   .000    .000 +-   .000   4.596 +-  4.504   7.071 +-  6.951
SEC SO4    4.025 +-  4.481   8.038 +- 16.076    .000 +-   .000    .000 +-   .000   4.025 +-  4.481   3.455 +-  6.910
---------------------------------------------------------------------------------------------------------
CALC.MASS 27.650 +-  7.882  98.750 +- 30.073  37.055 +- 13.502 100.148 +- 38.064  64.705 +- 15.634  99.546 +-   .002
MEAS.MASS 28.000 +-  3.000                    37.000 +-  4.000                    65.000 +-  5.000
```

TABLE C-7. GENERAL HARDCOPY OUTPUT FILE

```
RESULTS FOR CMB SITE: URBAN CORE       YEAR: 81   DATE: 0229
COARSE PARTICULATE FRACTION
SAMPLING DURATION: 12 HRS. WITH START HOUR:  7
BACKGROUND SITE SUBTRACTED: NO
                     RIDGE REGRESSION                         LEAST SQUARES
                     K= .800     R-SQUARE:  .6151             K=0.0     R-SQUARE:  .7702
-----------------------------------------------------------------------------------------
CODE  SOURCE            UG/M3                %                      UG/M3            VIF
-----------------------------------------------------------------------------------------
    INTERCEPT      .011+-    .005                               .023+-    .010
  1   SOIL       36.445+-  18.752   48.593+-25.410            77.894+-  81.347      6.178
  2   RD DUST    13.578+-   6.185   18.104+- 8.418            18.281+-  13.310      2.184
  3   SEA SALT     .177+-    .491     .328+-  .655              .365+-    .771      1.223
  5   AUTO CAT   10.339+-  13.655    9.126+-18.252           -51.096+-  63.596      6.754
  6   AUTO         .722+-    .275     .963+-  .378             1.180+-    .395      1.054
  9   DIST OIL     .000+-    .000     .000+-  .000              .000+-    .000       .000
 10   RES GAS      .000+-    .000     .000+-  .000              .000+-    .000       .000
 11   COAL        4.532+-   3.137    6.043+- 4.220            11.906+-   7.909      2.829
 12   KRAFT RB    2.229+-   3.455    2.308+- 4.615             -.031+-   6.302      1.564
 13   ELARCFRN     .000+-    .000     .000+-  .000              .000+-    .000       .000
 14   FERRMNFR     .000+-    .000     .000+-  .000              .000+-    .000       .000
 16   CEMENT     13.874+-  11.324   18.499+-15.197            23.364+-  20.317      1.550
 17   PET FCC      .000+-    .000     .000+-  .000              .000+-    .000       .000
 19   SEC SO4      .000+-    .000     .000+-  .000              .000+-    .000       .000
-----------------------------------------------------------------------------------------
      TOTAL:     81.908+-  25.267  109.210+-35.197            81.884+-  43.046

SPECIES    FIT  MISS          COARSE SUSPENDED PARTICULATE
CODE       FLG  FLG   MEAS. UG/M3          PERCENT        CALC. UG/M3       RATIO
-----------------------------------------------------------------------------------------
  1  TOTAL    *        75.000+- 7.000 100.000+-13.199    81.908+-25.267  1.092+-  .499  TOTAL
  2  AL       *         1.951+-  .422   2.601+-  .613     1.125+-  .229   .577+-  .136  AL
  3  AS                  .004+-  .004    .003+-  .005      .011+-  .000  2.762+-  .000  AS
  4  BA       *          .371+-  .023    .495+-  .055      .011+-  .000   .030+-  .000  BA
  5  BR       *          .108+-  .007    .144+-  .016      .073+-  .015   .672+-  .165  BR
  6  CA       *        13.014+- 1.442  17.352+- 2.514     5.186+-  .842   .399+-  .070  CA
  7  CD                      <   .001        <   .001      .011+-  .000 22.097+-  .000  CD
  8  CL       *          .288+-  .068    .384+-  .097      .212+-  .031   .736+-  .133  CL
  9  CO       *          .015+-  .003    .020+-  .004      .011+-  .000   .737+-  .035  CO
 10  CR       *          .022+-  .005    .029+-  .007      .022+-  .003   .989+-  .171  CR
 11  CU       *          .018+-  .002    .024+-  .003      .018+-  .001  1.010+-  .084  CU
 12  FE       *         1.871+-  .118   2.495+-  .281     1.204+-  .205   .643+-  .130  FE
 13  HG                      <   .001        <   .003      .011+-  .000 11.048+- 4.756  HG
 14  K        *          .517+-  .072    .689+-  .116      .347+-  .070   .672+-  .164  K
 15  MN       *          .088+-  .008    .117+-  .015      .035+-  .004   .398+-  .048  MN
 16  NI                  .003+-  .001    .004+-  .001      .018+-  .001  5.834+- 2.534  NI
 17  P        *          .102+-  .040    .136+-  .055      .011+-  .000   .108+-  .004  P
 18  PB       *          .346+-  .024    .461+-  .054      .171+-  .038   .494+-  .123  PB
 19  SO4                1.725+-  .939   2.300+- 1.270     6.525+- 1.306  3.782+- 2.962  SO4
 20  SB                  .004+-  .002    .005+-  .003      .011+-  .000  2.762+-  .000  SB
 21  SI       *         8.652+- 1.987  11.536+- 2.860     6.335+- 1.048   .732+-  .150  SI
 22  SN                  .005+-  .002    .007+-  .003      .011+-  .000  2.210+-  .000  SN
 23  SR       *          .030+-  .003    .040+-  .005      .016+-  .001   .538+-  .048  SR
 24  TI       *          .205+-  .037    .273+-  .056      .181+-  .035   .881+-  .229  TI
 25  V                       <   .007        <   .019      .015+-  .001  2.102+-  .307  V
 26  ZN       *          .071+-  .006    .095+-  .012      .054+-  .008   .756+-  .142  ZN
 27  C             M         <   .000        <   .001     8.129+- 1.224   .000+-  .000  C
 28  NA            M         <   .000        <   .001      .422+-  .068   .000+-  .000  NA
 29  NO3           M         <   .000        <   .001      .014+-  .001   .000+-  .000  NO3
 30  RB            M         <   .000        <   .001      .012+-  .000   .000+-  .000  RB
 31  SE            M         <   .000        <   .001      .011+-  .000   .000+-  .000  SE
-----------------------------------------------------------------------------------------
MEASURED AMBIENT MASS (UG/M3):  FINE:   35.0+- 7.0   COARSE:  75.0+- 7.0   TOTAL:  110.0+- 9.9
```

TABLE C-7 (CONTINUED)

```
RESULTS FOR CMB SITE: URBAN CORE          YEAR: 81   DATE: 0229
 FINE  PARTICULATE FRACTION
SAMPLING DURATION: 12 HRS. WITH START HOUR:  7
BACKGROUND SITE SUBTRACTED: NO
                        RIDGE REGRESSION                                    LEAST SQUARES
                        K= .010     R-SQUARE:  .9179                        K=0.0     R-SQUARE:  .9200
----------------------------------------------------------------------------------------------------
CODE  SOURCE                UG/M3               %                        UG/M3               VIF
----------------------------------------------------------------------------------------------------
      INTERCEPT       .004+-    .004
  1    SOIL         -.509+-   3.092    4.419+- 8.838               .005+-    .006
  2    RD DUST      -.024+-    .923    1.318+- 2.636             -8.858+-  27.313   432.869
  3    SEA SALT     -.446+-    .171     .276+-  .552               .891+-   3.239    29.638
  5    AUTO CAT     7.377+-  20.436   29.271+-58.541              -.533+-    .265    14.234
  6    AUTO         4.635+-    .941   13.244+- 3.773             -2.525+-  58.257    79.398
  9    DIST OIL     3.596+-   6.614    9.505+-19.009              4.800+-    .975     2.881
 10    RES GAS      1.015+-   5.311    7.593+-15.186              6.549+-  10.723    14.366
 11    COAL         1.771+-   1.348    5.059+- 3.981             15.427+-  49.140   413.108
 13    ELARCFRN      .076+-    .454     .648+- 1.296              2.192+-   2.462     9.374
 14    FERRMNFR      .061+-    .250     .358+-  .715               .048+-   1.249    71.640
 16    CEMENT       7.403+-   2.919   21.151+- 9.353               .083+-    .612    24.698
 17    PET FCC      8.221+-  12.252   17.660+-35.320              7.999+-   4.322     6.798
 19    SEC SO4      -.187+-  11.012   15.732+-31.464              9.410+-  41.216    77.121
                                                                 -3.353+-  49.346   173.618
----------------------------------------------------------------------------------------------------
      TOTAL:       32.991+-  15.162   94.261+-47.244             32.136+-  50.953

SPECIES     FIT  MISS           FINE  SUSPENDED PARTICULATE
CODE        FLG  FLG   MEAS. UG/M3          PERCENT          CALC. UG/M3        RATIO
----------------------------------------------------------------------------------------------------
  1  TOTAL   *          35.000+- 7.000 100.000+-28.284    32.991+-15.162   .943+-  .595  TOTAL
  2  AL      *            .088+-  .062     .251+-  .184     .029+-  .004    .331+-  .050  AL
  3  AS      *            .036+-  .007     .103+-  .029     .004+-  .000    .109+-  .000  AS
  4  BA      *            .149+-  .014     .426+-  .094     .004+-  .000    .028+-  .000  BA
  5  BR      *            .344+-  .017     .983+-  .202     .385+-  .095   1.119+-  .415  BR
  6  CA      *            .441+-  .023    1.260+-  .260     .441+-  .095    .999+-  .303  CA
  7  CD      *            .004+-  .002     .011+-  .006     .006+-  .000   1.375+-  .168  CD
  8  CL      *            .051+-  .007     .146+-  .035     .054+-  .088   1.049+- 2.510  CL
  9  CO      *            .003+-  .002     .009+-  .006     .004+-  .000   1.308+-  .081  CO
 10  CR                       <   .002         <   .011     .006+-  .000   2.912+-  .626  CR
 11  CU      *            .013+-  .002     .037+-  .009     .012+-  .002    .957+-  .170  CU
 12  FE      *            .208+-  .011     .594+-  .123     .207+-  .029    .994+-  .197  FE
 13  HG                       <   .000         <   .009     .004+-  .000    .000+-  .000  HG
 14  K       *            .165+-  .009     .471+-  .098     .161+-  .037    .973+-  .314  K
 15  MN      *            .022+-  .004     .063+-  .017     .022+-  .003   1.019+-  .202  MN
 16  NI      *            .006+-  .001     .017+-  .004     .006+-  .000   1.003+-  .075  NI
 17  P       *            .119+-  .017     .340+-  .084     .004+-  .000    .033+-  .001  P
 18  PB      *           1.422+-  .068    4.063+-  .835    1.014+-  .245    .713+-  .211  PB
 19  SO4     *          13.130+-  .681   37.514+- 7.751   13.151+- 1.780  1.002+-  .192  SO4
 20  SB      *            .003+-  .002     .009+-  .006     .004+-  .000   1.479+-  .076  SB
 21  SI      *            .277+-  .031     .791+-  .181     .290+-  .050   1.045+-  .261  SI
 22  SN                       <   .001         <   .006     .019+-  .004  18.516+-67.641  SN
 23  SR      *            .003+-  .001     .009+-  .003     .004+-  .000   1.261+-  .019  SR
 24  TI                       <   .007         <   .040     .005+-  .001    .768+-  .102  TI
 25  V                        <   .002         <   .023     .004+-  .000   2.080+-  .056  V
 26  ZN      *            .042+-  .003     .120+-  .025     .042+-  .007    .995+-  .247  ZN
 27  C            M           <   .000         <   .003    7.740+- 1.024    .000+-  .000  C
 28  NA           M           <   .000         <   .003    -.116+-  .035    .000+-  .000  NA
 29  NO3          M           <   .000         <   .003     .043+-  .009    .000+-  .000  NO3
 30  RB           M           <   .000         <   .003     .004+-  .000    .000+-  .000  RB
 31  SE           M           <   .000         <   .003     .004+-  .000    .000+-  .000  SE
----------------------------------------------------------------------------------------------------
MEASURED AMBIENT MASS (UG/M3):  FINE:   35.0+- 7.0   COARSE:  75.0+- 7.0   TOTAL:  110.0+- 9.9
```

TABLE C-7 (CONTINUED)

```
RESULTS FOR CMB SITE: URBAN CORE       YEAR: 81   DATE: 0229
COARSE PARTICULATE FRACTION
SAMPLING DURATION: 12 HRS. WITH START HOUR:  7
BACKGROUND SITE SUBTRACTED: NO
                           RIDGE REGRESSION                            LEAST SQUARES
                           K= .800     R-SQUARE:  .6151                K=0.0      R-SQUARE:  .7702
----------------------------------------------------------------------------------------------------
CODE  SOURCE                 UG/M3                %                          UG/M3              VIF
----------------------------------------------------------------------------------------------------
     INTERCEPT         .011+-    .005                                  .023+-    .010
  1   SOIL           36.445+-  18.752   48.593+-25.410               77.894+-  81.347       6.178
  2   RD DUST        13.578+-   6.185   18.104+- 8.418               18.281+-  13.310       2.184
  3   SEA SALT         .177+-    .491     .328+-  .655                 .365+-    .771       1.223
  5   AUTO CAT       10.339+-  13.655    9.126+-18.252              -51.096+-  63.596       6.754
  6   AUTO             .722+-    .275     .963+-  .378                1.180+-    .395       1.054
  9   DIST OIL         .000+-    .000     .000+-  .000                 .000+-    .000        .000
 10   RES GAS          .000+-    .000     .000+-  .000                 .000+-    .000        .000
 11   COAL            4.532+-   3.137    6.043+- 4.220               11.906+-   7.909       2.829
 12   KRAFT RB        2.229+-   3.455    2.308+- 4.615                -.031+-   6.302       1.564
 13   ELARCFRN         .000+-    .000     .000+-  .000                 .000+-    .000        .000
 14   FERRMNFR         .000+-    .000     .000+-  .000                 .000+-    .000        .000
 16   CEMENT         13.874+-  11.324   18.499+-15.197               23.364+-  20.317       1.550
 17   PET FCC          .000+-    .000     .000+-  .000                 .000+-    .000        .000
 19   SEC SO4          .000+-    .000     .000+-  .000                 .000+-    .000        .000
----------------------------------------------------------------------------------------------------
      TOTAL:         81.908+-  25.267  109.210+-35.197               81.884+-  43.046

SPECIES     FIT  MISS           COARSE SUSPENDED PARTICULATE
CODE        FLG  FLG   MEAS. UG/M3          PERCENT          CALC. UG/M3        RATIO
----------------------------------------------------------------------------------------------------
  1  TOTAL   *          75.000+- 7.000 100.000+-13.199    81.908+-25.267  1.092+-  .499  TOTAL
  2  AL      *           1.951+-  .422   2.601+-  .613     1.125+-  .229   .577+-  .136  AL
  3  AS                   .004+-  .004    .003+-  .005      .011+-  .000  2.762+-  .000  AS
  4  BA      *            .371+-  .023    .495+-  .055      .011+-  .000   .030+-  .000  BA
  5  BR      *            .108+-  .007    .144+-  .016      .073+-  .015   .672+-  .165  BR
  6  CA      *          13.014+- 1.442  17.352+- 2.514     5.186+-  .842   .399+-  .070  CA
  7  CD                      <    .001         <  .001      .011+-  .000 22.097+-  .000  CD
  8  CL      *            .288+-  .068    .384+-  .097      .212+-  .031   .736+-  .133  CL
  9  CO      *            .015+-  .003    .020+-  .004      .011+-  .000   .737+-  .035  CO
 10  CR      *            .022+-  .005    .029+-  .007      .022+-  .003   .989+-  .171  CR
 11  CU      *            .018+-  .002    .024+-  .003      .018+-  .001  1.010+-  .084  CU
 12  FE      *           1.871+-  .118   2.495+-  .281     1.204+-  .205   .643+-  .130  FE
 13  HG                      <    .001         <  .003      .011+-  .000 11.048+- 4.756  HG
 14  K       *            .517+-  .072    .689+-  .116      .347+-  .070   .672+-  .164  K
 15  MN      *            .088+-  .008    .117+-  .015      .035+-  .004   .398+-  .048  MN
 16  NI                   .003+-  .001    .004+-  .001      .018+-  .001  5.834+- 2.534  NI
 17  P       *            .102+-  .040    .136+-  .055      .011+-  .000   .108+-  .004  P
 18  PB      *            .346+-  .024    .461+-  .054      .171+-  .038   .494+-  .123  PB
 19  SO4                 1.725+-  .939   2.300+- 1.270     6.525+- 1.306  3.782+- 2.962  SO4
 20  SB                   .004+-  .002    .005+-  .003      .011+-  .000  2.762+-  .000  SB
 21  SI      *           8.652+- 1.987  11.536+- 2.860     6.335+- 1.048   .732+-  .150  SI
 22  SN                   .005+-  .002    .007+-  .003      .011+-  .000  2.210+-  .000  SN
 23  SR      *            .030+-  .003    .040+-  .005      .016+-  .001   .538+-  .048  SR
 24  TI      *            .205+-  .037    .273+-  .056      .181+-  .035   .881+-  .229  TI
 25  V                       <    .007         <  .019      .015+-  .001  2.102+-  .307  V
 26  ZN      *            .071+-  .006    .095+-  .012      .054+-  .008   .756+-  .142  ZN
 27  C            M          <    .000         <  .001     8.129+- 1.224   .000+-  .000  C
 28  NA           M          <    .000         <  .001      .422+-  .068   .000+-  .000  NA
 29  NO3          M          <    .000         <  .001      .014+-  .001   .000+-  .000  NO3
 30  RB           M          <    .000         <  .001      .012+-  .000   .000+-  .000  RB
 31  SE           M          <    .000         <  .001      .011+-  .000   .000+-  .000  SE
----------------------------------------------------------------------------------------------------
MEASURED AMBIENT MASS (UG/M3):  FINE:   35.0+- 7.0   COARSE:  75.0+- 7.0   TOTAL:  110.0+- 9.9
```

TABLE C-7 (CONTINUED)

```
RESULTS FOR CMB SITE: URBAN CORE       YEAR: 81   DATE: 0229
TOTAL  PARTICULATE FRACTION
SAMPLING DURATION: 12 HRS. WITH START HOUR:  7
BACKGROUND SITE SUBTRACTED: NO
RESULTS DERIVED FROM FINE AND COARSE FITTINGS

---------------------------------------------------------------------------------------------
CODE  SOURCE            UG/M3              %
---------------------------------------------------------------------------------------------
     INTERCEPT      .015+-    .006
  1   SOIL        35.936+-  19.005   32.669+-17.525
  2   RD DUST     13.554+-   6.254   12.321+- 5.792
  3   SEA SALT    -.270+-     .520     .237+-  .473
  5   AUTO CAT    17.717+-  24.579   11.196+-22.391
  6   AUTO         5.358+-    .980    4.871+-  .993
  9   DIST OIL     3.596+-   6.614    3.010+- 6.020
 10   RES GAS      1.015+-   5.311    2.415+- 4.829
 11   COAL         6.303+-   3.414    5.730+- 3.146
 12   KRAFT RB     2.229+-   3.455    1.573+- 3.146
 13   ELARCFRN      .076+-    .454     .206+-  .412
 14   FERRMNFR      .061+-    .250     .114+-  .227
 16   CEMENT      21.277+-  11.694   19.343+-10.773
 17   PET FCC      8.221+-  12.252    5.579+-11.159
 19   SEC SO4      -.187+-  11.012    5.006+-10.011
---------------------------------------------------------------------------------------------
      TOTAL:     114.899+-  29.467  104.454+-28.390

SPECIES     FIT  MISS            TOTAL  SUSPENDED PARTICULATE
CODE        FLG  FLG   MEAS. UG/M3           PERCENT          CALC. UG/M3       RATIO
---------------------------------------------------------------------------------------------
  1  TOTAL    *       110.000+- 9.899 100.000+-12.727   114.899+-29.467  1.045+-  .387  TOTAL
  2  AL       *         2.039+-  .427   1.854+-  .422     1.154+-  .229   .566+-  .129  AL
  3  AS                  .040+-  .008    .036+-  .008      .015+-  .000   .374+-  .000  AS
  4  BA       *          .520+-  .027    .473+-  .049      .015+-  .000   .029+-  .000  BA
  5  BR       *          .452+-  .018    .411+-  .041      .458+-  .096  1.013+-  .303  BR
  6  CA       *        13.455+- 1.442  12.232+- 1.712     5.627+-  .847   .418+-  .068  CA
  7  CD                  .004+-  .002    .004+-  .002      .017+-  .000  3.677+-  .334  CD
  8  CL       *          .339+-  .068    .308+-  .068      .266+-  .094   .783+-  .350  CL
  9  CO       *          .018+-  .004    .016+-  .004      .015+-  .000   .832+-  .033  CO
 10  CR       *          .024+-  .006    .022+-  .006      .028+-  .003  1.149+-  .172  CR
 11  CU       *          .031+-  .003    .028+-  .004      .031+-  .002   .988+-  .087  CU
 12  FE       *         2.079+-  .119   1.890+-  .201     1.411+-  .207   .679+-  .120  FE
 13  HG                     <    .001         <    .003      .015+-  .000 14.973+- 6.801  HG
 14  K        *          .682+-  .073    .620+-  .086      .508+-  .079   .745+-  .145  K
 15  MN       *          .110+-  .009    .100+-  .012      .057+-  .005   .522+-  .051  MN
 16  NI                  .009+-  .001    .008+-  .001      .024+-  .001  2.613+-  .411  NI
 17  P        *          .221+-  .043    .201+-  .043      .015+-  .000   .068+-  .002  P
 18  PB       *         1.768+-  .072   1.607+-  .159     1.184+-  .248   .670+-  .169  PB
 19  SO4               14.855+- 1.160  13.505+- 1.609    19.676+- 2.208  1.325+-  .247  SO4
 20  SB                  .007+-  .003    .006+-  .003      .015+-  .000  2.212+-  .044  SB
 21  SI       *         8.929+- 1.987   8.117+- 1.949     6.624+- 1.050   .742+-  .146  SI
 22  SN                  .006+-  .003    .005+-  .003      .030+-  .004  4.927+- 3.057  SN
 23  SR       *          .033+-  .003    .030+-  .004      .020+-  .001   .604+-  .045  SR
 24  TI       *          .212+-  .040    .193+-  .040      .186+-  .035   .877+-  .221  TI
 25  V                      <    .009         <    .015      .019+-  .001  2.097+-  .239  V
 26  ZN       *          .113+-  .007    .103+-  .011      .095+-  .011   .845+-  .126  ZN
 27  C             M        <    .000         <    .001    15.870+- 1.596   .000+-  .000  C
 28  NA            M        <    .000         <    .001      .305+-  .076   .000+-  .000  NA
 29  NO3           M        <    .000         <    .001      .057+-  .009   .000+-  .000  NO3
 30  RB            M        <    .000         <    .001      .016+-  .000   .000+-  .000  RB
 31  SE            M        <    .000         <    .001      .015+-  .000   .000+-  .000  SE
---------------------------------------------------------------------------------------------
MEASURED AMBIENT MASS (UG/M3):  FINE:   35.0+- 7.0   COARSE:  75.0+- 7.0   TOTAL:  110.0+- 9.9
```

TABLE C-7 (CONTINUED)

```
RESULTS FOR CMB SITE: BACKGROUND       YEAR: 81   DATE: 0229
 FINE  PARTICULATE FRACTION
SAMPLING DURATION: 12 HRS. WITH START HOUR:  7
BACKGROUND SITE SUBTRACTED: NO
                     RIDGE REGRESSION                          LEAST SQUARES
                     K= .120    R-SQUARE:  .8287               K=0.0     R-SQUARE:  .9241
------------------------------------------------------------------------------------------
CODE  SOURCE              UG/M3               %                      UG/M3          VIF
------------------------------------------------------------------------------------------
    INTERCEPT       .006+-    .006                              .005+-    .006
  1   SOIL         -.334+-    .346     .622+- 1.243          -14.654+-  34.854  7594.633
  2   RD DUST       .214+-    .656    1.171+- 2.343            1.231+-   3.814    91.330
  3   SEA SALT     -.187+-    .093     .170+-  .341            -.667+-    .264    19.554
  5   AUTO CAT    12.538+-   7.325   44.778+-26.596          -26.438+-  39.874    52.511
  6   AUTO         1.889+-    .609    6.745+- 2.291            2.261+-    .522     1.823
  9   DIST OIL     1.572+-   3.786    6.768+-13.536           20.923+-  12.055    25.512
 10   RES GAS      -.735+-    .733    1.316+- 2.632           17.660+-  61.095  6725.402
 11   COAL         1.088+-    .951    3.887+- 3.420            3.035+-   2.132    13.675
 13   ELARCFRN     -.053+-    .114     .204+-  .408            -.117+-    .974    93.757
 14   FERRMNFR      .147+-    .137     .523+-  .492             .186+-    .498    22.554
 16   CEMENT       2.884+-   1.166   10.300+- 4.307            9.390+-   3.855    30.223
 17   PET FCC      4.596+-   4.504   16.416+-16.183            6.337+-  24.170    55.903
 19   SEC SO4      4.025+-   4.481    8.038+-16.076            7.995+-  30.701    78.138
------------------------------------------------------------------------------------------
     TOTAL:       27.650+-   7.882   98.750+-30.073           27.147+-  20.851

SPECIES    FIT  MISS            FINE  SUSPENDED PARTICULATE
CODE       FLG  FLG   MEAS. UG/M3          PERCENT        CALC. UG/M3        RATIO
------------------------------------------------------------------------------------------
  1  TOTAL   *         28.000+- 3.000 100.000+-15.152    27.650+- 7.882   .988+-  .396  TOTAL
  2  AL      *            .070+-  .055    .250+-  .198      .048+-  .006   .692+-  .110  AL
  3  AS      *            .014+-  .006    .050+-  .022      .006+-  .000   .403+-  .000  AS
  4  BA      *            .146+-  .018    .521+-  .085      .006+-  .000   .040+-  .000  BA
  5  BR      *            .164+-  .010    .586+-  .072      .161+-  .039   .983+-  .331  BR
  6  CA      *            .128+-  .008    .457+-  .057      .133+-  .039  1.039+-  .437  CA
  7  CD      *                 <  .001         <  .007      .007+-  .000  6.613+- 1.623  CD
  8  CL      *            .010+-  .007    .036+-  .025      .023+-  .037  2.319+- 9.227  CL
  9  CO      *            .008+-  .003    .029+-  .011      .006+-  .000   .705+-  .022  CO
 10  CR                   .010+-  .005    .036+-  .018      .005+-  .000   .487+-  .031  CR
 11  CU      *            .027+-  .003    .096+-  .015      .011+-  .001   .426+-  .041  CU
 12  FE      *            .120+-  .008    .429+-  .054      .116+-  .018   .963+-  .205  FE
 13  HG                        <  .001         <  .011      .006+-  .000  3.763+-  .377  HG
 14  K       *            .186+-  .010    .664+-  .080      .086+-  .015   .461+-  .089  K
 15  MN      *            .022+-  .004    .079+-  .017      .029+-  .006  1.303+-  .482  MN
 16  NI      *            .003+-  .002    .011+-  .007      .007+-  .000  2.463+-  .421  NI
 17  P       *            .103+-  .018    .368+-  .075      .006+-  .000   .055+-  .001  P
 18  PB      *            .894+-  .047   3.193+-  .381      .420+-  .100   .470+-  .123  PB
 19  SO4     *          14.780+-  .765  52.786+- 6.281    14.288+- 1.728   .967+-  .163  SO4
 20  SB      *            .008+-  .003    .029+-  .011      .006+-  .000   .745+-  .012  SB
 21  SI      *            .189+-  .027    .675+-  .121      .225+-  .029  1.188+-  .236  SI
 22  SN                   .024+-  .003    .086+-  .014      .015+-  .002   .609+-  .109  SN
 23  SR      *            .003+-  .002    .011+-  .007      .006+-  .000  1.850+-  .016  SR
 24  TI                        <  .008         <  .057      .008+-  .000   .978+-  .086  TI
 25  V                         <  .003         <  .032      .006+-  .000  1.925+-  .019  V
 26  ZN      *            .038+-  .003    .136+-  .018      .035+-  .005   .911+-  .181  ZN
 27  C            M            <  .000         <  .004     6.858+- 1.259   .000+-  .000  C
 28  NA           M            <  .000         <  .004     -.038+-  .015   .000+-  .000  NA
 29  NO3          M            <  .000         <  .004      .030+-  .004   .000+-  .000  NO3
 30  RB           M            <  .000         <  .004      .006+-  .000   .000+-  .000  RB
 31  SE           M            <  .000         <  .004      .006+-  .000   .000+-  .000  SE
------------------------------------------------------------------------------------------
MEASURED AMBIENT MASS (UG/M3):  FINE:   28.0+- 3.0   COARSE:  37.0+- 4.0   TOTAL:   65.0+- 5.0
```

TABLE C-7 (CONTINUED)

```
RESULTS FOR CMB SITE: BACKGROUND       YEAR: 81   DATE: 0229
COARSE PARTICULATE FRACTION
SAMPLING DURATION: 12 HRS. WITH START HOUR:  7
BACKGROUND SITE SUBTRACTED: NO
                        RIDGE REGRESSION                                LEAST SQUARES
                        K= .480     R-SQUARE:  .8785                    K=0.0     R-SQUARE:  .9570
------------------------------------------------------------------------------------------------------
CODE  SOURCE                UG/M3                 %                           UG/M3            VIF
------------------------------------------------------------------------------------------------------
      INTERCEPT        .003+-    .002                                   .003+-    .003
  1    SOIL          20.253+-   5.861   54.738+-16.911                27.211+-  16.919       7.651
  2    RD DUST        6.130+-   1.363   16.567+- 4.097                 7.989+-   2.435       3.687
  3    SEA SALT       -.024+-    .031     .042+-  .084                 -.053+-    .114      10.065
  5    AUTO CAT       1.749+-   4.822    6.522+-13.043                -9.926+-  14.544       8.157
  6    AUTO            .540+-    .106    1.460+-  .327                  .820+-    .099       1.130
  9    DIST OIL        .000+-    .000     .000+-  .000                  .000+-    .000        .000
 10    RES GAS         .000+-    .000     .000+-  .000                  .000+-    .000        .000
 11    COAL           1.397+-    .840    3.775+- 2.307                 2.655+-   1.708       4.580
 12    KRAFT RB        .053+-    .538     .726+- 1.453                 -.156+-   2.073      10.701
 13    ELARCFRN        .000+-    .000     .000+-  .000                  .000+-    .000        .000
 14    FERRMNFR        .000+-    .000     .000+-  .000                  .000+-    .000        .000
 16    CEMENT         6.954+-   2.694   18.796+- 7.558                 9.610+-   3.288       1.852
 17    PET FCC         .000+-    .000     .000+-  .000                  .000+-    .000        .000
 19    SEC SO4         .000+-    .000     .000+-  .000                  .000+-    .000        .000
------------------------------------------------------------------------------------------------------
       TOTAL:        37.055+-  13.502  100.148+-38.064                38.153+-  21.236

SPECIES     FIT  MISS          COARSE SUSPENDED PARTICULATE
CODE        FLG  FLG   MEAS. UG/M3          PERCENT        CALC. UG/M3        RATIO
------------------------------------------------------------------------------------------------------
  1  TOTAL   *        37.000+- 4.000 100.000+-15.289   37.055+-13.502  1.001+-  .516  TOTAL
  2  AL      *          .739+-  .171   1.997+-  .510     .521+-  .105   .705+-  .173  AL
  3  AS                      <  .001         <  .011     .003+-  .000  2.948+-  .000  AS
  4  BA      *          .086+-  .016    .232+-  .050     .003+-  .000   .034+-  .000  BA
  5  BR      *          .064+-  .005    .173+-  .023     .048+-  .011   .746+-  .216  BR
  6  CA      *         3.805+-  .444  10.284+- 1.636    2.646+-  .436   .696+-  .139  CA
  7  CD                      <  .001         <  .005     .003+-  .000  2.948+-  .000  CD
  8  CL      *          .014+-  .010    .038+-  .027     .020+-  .008  1.460+- 1.013  CL
  9  CO      *               <  .001         <  .008     .003+-  .000  2.948+-  .697  CO
 10  CR      *               <  .003         <  .014     .003+-  .000  1.281+-  .041  CR
 11  CU      *          .004+-  .002    .011+-  .006     .005+-  .000  1.311+-  .189  CU
 12  FE      *          .692+-  .044   1.870+-  .235     .513+-  .092   .741+-  .166  FE
 13  HG                 .009+-  .003    .024+-  .009     .003+-  .000   .328+-  .026  HG
 14  K       *          .215+-  .032    .581+-  .107     .167+-  .035   .777+-  .208  K
 15  MN      *          .018+-  .004    .049+-  .012     .014+-  .002   .757+-  .130  MN
 16  NI                      <  .001         <  .005     .003+-  .000  3.327+-  .247  NI
 17  P       *               <  .020         <  .060     .003+-  .000   .147+-  .011  P
 18  PB      *          .213+-  .017    .576+-  .077     .121+-  .029   .568+-  .154  PB
 19  SO4                .852+-  .783   2.303+- 2.131    1.315+-  .229  1.544+-  .495  SO4
 20  SB                      <  .001         <  .008     .003+-  .000  2.948+-  .000  SB
 21  SI      *         4.000+-  .914  10.811+- 2.733    2.981+-  .484   .745+-  .151  SI
 22  SN                 .003+-  .003    .004+-  .008     .003+-  .000   .983+-  .000  SN
 23  SR      *          .006+-  .002    .016+-  .006     .006+-  .001   .964+-  .164  SR
 24  TI      *          .097+-  .017    .262+-  .054     .083+-  .016   .854+-  .219  TI
 25  V                       <  .003         <  .019     .005+-  .000  1.315+-  .197  V
 26  ZN      *          .016+-  .003    .043+-  .009     .016+-  .002   .989+-  .216  ZN
 27  C            M          <  .000         <  .003    2.610+-  .386   .000+-  .000  C
 28  NA           M          <  .000         <  .003     .106+-  .027   .000+-  .000  NA
 29  NO3          M          <  .000         <  .003     .004+-  .000   .000+-  .000  NO3
 30  RB           M          <  .000         <  .003     .003+-  .000   .000+-  .000  RB
 31  SE           M          <  .000         <  .003     .003+-  .000   .000+-  .000  SE
------------------------------------------------------------------------------------------------------
MEASURED AMBIENT MASS (UG/M3):  FINE:   28.0+- 3.0   COARSE:  37.0+- 4.0   TOTAL:   65.0+- 5.0
```

TABLE C-7 (CONTINUED)

```
RESULTS FOR CMB SITE: BACKGROUND       YEAR: 81   DATE: 0229
TOTAL  PARTICULATE FRACTION
SAMPLING DURATION: 12 HRS. WITH START HOUR:  7
BACKGROUND SITE SUBTRACTED: NO
RESULTS DERIVED FROM FINE AND COARSE FITTINGS

-------------------------------------------------------------------------------------------
CODE  SOURCE             UG/M3              %
-------------------------------------------------------------------------------------------
     INTERCEPT       .009+-   .006
 1    SOIL         19.919+-  5.872   30.645+- 9.336
 2    RD DUST       6.343+-  1.513    9.759+- 2.445
 3    SEA SALT      -.211+-   .098     .077+-  .153
 5    AUTO CAT     14.287+-  8.770   21.980+-13.597
 6    AUTO          2.429+-   .618    3.736+-  .993
 9    DIST OIL      1.572+-  3.786    2.914+- 5.828
10    RES GAS       -.735+-   .733     .565+- 1.131
11    COAL          2.485+-  1.269    3.823+- 1.974
12    KRAFT RB       .053+-   .538     .413+-  .827
13    ELARCFRN      -.053+-   .114     .088+-  .176
14    FERRMNFR       .147+-   .137     .225+-  .211
16    CEMENT        9.838+-  2.935   15.136+- 4.663
17    PET FCC       4.596+-  4.504    7.071+- 6.951
19    SEC SO4       4.025+-  4.481    3.455+- 6.910
--------------------------------------------------------------------------------------------
      TOTAL:       64.705+-  15.634  99.546+-25.242

SPECIES    FIT  MISS          TOTAL  SUSPENDED PARTICULATE
CODE       FLG  FLG   MEAS. UG/M3          PERCENT        CALC. UG/M3       RATIO
--------------------------------------------------------------------------------------------
  1  TOTAL   *        65.000+- 5.000 100.000+-10.879    64.705+-15.634   .995+-  .339  TOTAL
  2  AL      *          .809+-  .180   1.245+-  .292       .569+-  .105   .704+-  .159  AL
  3  AS                 .015+-  .007    .023+-  .011       .009+-  .000   .573+-  .000  AS
  4  BA      *          .232+-  .024    .357+-  .046       .009+-  .000   .038+-  .000  BA
  5  BR      *          .228+-  .011    .351+-  .032       .209+-  .040   .916+-  .240  BR
  6  CA      *         3.933+-  .444   6.051+-  .827      2.780+-  .437   .707+-  .136  CA
  7  CD                     <   .002         <  .004       .010+-  .000  4.780+-  .593  CD
  8  CL      *          .024+-  .012    .037+-  .019       .044+-  .037  1.818+- 3.233  CL
  9  CO      *          .009+-  .004    .014+-  .007       .009+-  .000   .955+-  .041  CO
 10  CR      *          .012+-  .007    .019+-  .011       .008+-  .000   .646+-  .027  CR
 11  CU      *          .031+-  .004    .048+-  .007       .017+-  .001   .540+-  .041  CU
 12  FE      *          .812+-  .045   1.249+-  .118       .628+-  .094   .774+-  .146  FE
 13  HG                 .010+-  .004    .016+-  .007       .009+-  .000   .818+-  .033  HG
 14  K       *          .401+-  .034    .617+-  .070       .253+-  .038   .631+-  .113  K
 15  MN      *          .040+-  .006    .062+-  .010       .042+-  .007  1.057+-  .245  MN
 16  NI                 .004+-  .003    .006+-  .004       .011+-  .000  2.679+-  .343  NI
 17  P       *          .123+-  .028    .189+-  .046       .009+-  .000   .070+-  .002  P
 18  PB      *         1.107+-  .050   1.703+-  .152       .541+-  .104   .489+-  .104  PB
 19  SO4              15.632+- 1.095  24.049+- 2.502    15.603+- 1.743   .998+-  .158  SO4
 20  SB                 .009+-  .004    .014+-  .007       .009+-  .000   .990+-  .012  SB
 21  SI      *         4.189+-  .914   6.445+- 1.492      3.205+-  .485   .765+-  .146  SI
 22  SN                 .027+-  .004    .042+-  .007       .018+-  .002   .650+-  .099  SN
 23  SR      *          .009+-  .003    .014+-  .004       .011+-  .001  1.259+-  .127  SR
 24  TI      *          .105+-  .023    .162+-  .038       .091+-  .016   .864+-  .203  TI
 25  V                      <   .006         <  .018       .010+-  .000  1.596+-  .121  V
 26  ZN      *          .054+-  .004    .083+-  .009       .050+-  .006   .934+-  .143  ZN
 27  C            M         <   .000         <  .002      9.468+- 1.317   .000+-  .000  C
 28  NA           M         <   .000         <  .002       .067+-  .031   .000+-  .000  NA
 29  NO3          M         <   .000         <  .002       .034+-  .004   .000+-  .000  NO3
 30  RB           M         <   .000         <  .002       .009+-  .000   .000+-  .000  RB
 31  SE           M         <   .000         <  .002       .009+-  .000   .000+-  .000  SE
--------------------------------------------------------------------------------------------
MEASURED AMBIENT MASS (UG/M3):  FINE:   28.0+- 3.0   COARSE:  37.0+- 4.0   TOTAL:   65.0+- 5.0
```

TABLE C-7 (CONTINUED)

```
RIDGE K          .000            .005            .010            .015            .020            .025            .030
INTERCEPT        .004+-  .003    .004+-  .003    .004+-  .002    .004+-  .002    .004+-  .002    .004+-  .002    .004+-  .002
SOIL          22.079+-19.624  21.180+-17.940  20.448+-16.547  19.828+-15.377  19.299+-14.382  18.844+-13.527  18.449+-12.785
RD DUST        8.616+- 3.282   8.667+- 3.164   8.701+- 3.066   8.722+- 2.984   8.734+- 2.916   8.739+- 2.857   8.737+- 2.805
SEA SALT       -.054+-  .120   -.052+-  .115   -.050+-  .110   -.049+-  .105   -.048+-  .101   -.047+-  .098   -.046+-  .094
AUTO CAT      -6.547+-16.549  -5.666+-15.120  -4.919+-13.942  -4.267+-12.949  -3.692+-12.102  -3.181+-11.371  -2.723+-10.735
AUTO            .847+-  .286    .841+-  .282    .836+-  .278    .831+-  .275    .825+-  .272    .820+-  .269    .815+-  .266
COAL           2.268+- 2.178   2.174+- 2.022   2.093+- 1.896   2.021+- 1.790   1.958+- 1.699   1.902+- 1.620   1.851+- 1.552
KRAFT RB       -.203+- 1.980   -.220+- 1.894   -.234+- 1.815   -.245+- 1.743   -.254+- 1.677   -.260+- 1.616   -.266+- 1.559
CEMENT        10.305+- 5.092  10.365+- 4.964  10.399+- 4.842  10.419+- 4.735  10.427+- 4.641  10.425+- 4.557  10.415+- 4.481

RIDGE K          .035            .040            .045            .050            .060            .070            .080
INTERCEPT        .003+-  .002    .003+-  .002    .003+-  .002    .003+-  .002    .003+-  .002    .003+-  .002    .003+-  .002
SOIL          18.106+-12.136  17.806+-11.565  17.542+-11.059  17.309+-10.608  16.920+- 9.841  16.609+- 9.214  16.360+- 8.692
RD DUST        8.730+- 2.759   8.720+- 2.719   8.706+- 2.682   8.689+- 2.648   8.648+- 2.588   8.601+- 2.536   8.549+- 2.490
SEA SALT       -.045+-  .091   -.044+-  .088   -.043+-  .085   -.042+-  .082   -.041+-  .078   -.040+-  .073   -.039+-  .069
AUTO CAT      -2.310+-10.177  -1.936+- 9.684  -1.596+- 9.246  -1.284+- 8.854   -.735+- 8.186   -.264+- 7.637    .144+- 7.178
AUTO            .810+-  .263    .805+-  .260    .800+-  .257    .795+-  .255    .785+-  .250    .776+-  .245    .767+-  .240
COAL           1.805+- 1.492   1.763+- 1.439   1.725+- 1.392   1.690+- 1.350   1.627+- 1.278   1.574+- 1.219   1.527+- 1.170
KRAFT RB       -.270+- 1.506   -.272+- 1.457   -.274+- 1.411   -.275+- 1.368   -.276+- 1.290   -.274+- 1.221   -.271+- 1.160
CEMENT        10.399+- 4.411  10.378+- 4.346  10.353+- 4.286  10.325+- 4.229  10.260+- 4.125  10.189+- 4.032  10.113+- 3.948

RIDGE K          .090            .100            .120            .140            .160            .180            .200
INTERCEPT        .003+-  .002    .003+-  .002    .003+-  .002    .003+-  .002    .003+-  .002    .003+-  .002    .003+-  .002
SOIL          16.158+- 8.252  15.993+- 7.878  15.742+- 7.274  15.567+- 6.810  15.441+- 6.443  15.349+- 6.147  15.279+- 5.904
RD DUST        8.494+- 2.448   8.437+- 2.411   8.320+- 2.344   8.200+- 2.286   8.081+- 2.235   7.963+- 2.190   7.848+- 2.150
SEA SALT       -.037+-  .066   -.037+-  .063   -.035+-  .058   -.033+-  .054   -.032+-  .050   -.031+-  .047   -.029+-  .045
AUTO CAT        .501+- 6.792    .817+- 6.462   1.351+- 5.930   1.785+- 5.522   2.147+- 5.201   2.453+- 4.943   2.715+- 4.733
AUTO            .758+-  .236    .749+-  .232    .732+-  .225    .716+-  .218    .701+-  .212    .687+-  .206    .673+-  .201
COAL           1.486+- 1.128   1.449+- 1.092   1.387+- 1.034   1.335+-  .990   1.292+-  .954   1.255+-  .925   1.223+-  .902
KRAFT RB       -.267+- 1.105   -.262+- 1.055   -.252+-  .971   -.240+-  .901   -.228+-  .843   -.216+-  .794   -.204+-  .752
CEMENT        10.035+- 3.870   9.955+- 3.799   9.794+- 3.672   9.635+- 3.562   9.480+- 3.465   9.329+- 3.380   9.184+- 3.305

RIDGE K          .240            .280            .320            .360            .400            .480            .560
INTERCEPT        .003+-  .002    .003+-  .002    .003+-  .002    .003+-  .002    .003+-  .002    .003+-  .002    .002+-  .002
SOIL          15.178+- 5.531  15.109+- 5.261  15.054+- 5.059  15.004+- 4.905  14.955+- 4.785  14.845+- 4.615  14.727+- 4.505
RD DUST        7.626+- 2.082   7.416+- 2.024   7.218+- 1.976   7.030+- 1.934   6.853+- 1.898   6.527+- 1.838   6.234+- 1.788
SEA SALT       -.027+-  .041   -.025+-  .037   -.024+-  .035   -.022+-  .033   -.021+-  .032   -.018+-  .030   -.016+-  .029
AUTO CAT       3.143+- 4.413   3.474+- 4.185   3.738+- 4.018   3.952+- 3.892   4.128+- 3.797   4.397+- 3.664   4.584+- 3.583
AUTO            .647+-  .192    .624+-  .184    .602+-  .178    .582+-  .172    .564+-  .167    .531+-  .159    .502+-  .152
COAL           1.170+-  .865   1.128+-  .839   1.094+-  .819   1.065+-  .804   1.040+-  .792   1.001+-  .775    .970+-  .764
KRAFT RB       -.181+-  .686   -.159+-  .636   -.139+-  .598   -.120+-  .568   -.103+-  .545   -.072+-  .511   -.046+-  .488
CEMENT         8.910+- 3.179   8.655+- 3.076   8.419+- 2.992   8.199+- 2.921   7.993+- 2.862   7.619+- 2.769   7.284+- 2.695

RIDGE K          .640            .720            .800
INTERCEPT        .002+-  .002    .002+-  .002    .002+-  .002
SOIL          14.595+- 4.431  14.452+- 4.380  14.300+- 4.343
RD DUST        5.967+- 1.746   5.725+- 1.708   5.502+- 1.674
SEA SALT       -.015+-  .028   -.013+-  .027   -.012+-  .026
AUTO CAT       4.717+- 3.532   4.811+- 3.500   4.875+- 3.479
AUTO            .476+-  .146    .454+-  .141    .433+-  .137
COAL            .945+-  .756    .925+-  .750    .908+-  .744
KRAFT RB       -.023+-  .473   -.003+-  .462    .014+-  .454
CEMENT         6.983+- 2.636   6.710+- 2.586   6.460+- 2.542
```

TABLE C-8. USER FOLLOWUP OUTPUT FILE

```
 3 URBAN CORE   810229 12  7    12
30 URBAN CORE   810229 12  7     1    35.0000     7.0000    75.0000     7.0000
30 URBAN CORE   810229 12  7     2      .0880      .0620     1.9510      .4220
30 URBAN CORE   810229 12  7     3      .0360      .0070      .0040      .0040
30 URBAN CORE   810229 12  7     4      .1490      .0140      .3710      .0230
30 URBAN CORE   810229 12  7     5      .3440      .0170      .1080      .0070
30 URBAN CORE   810229 12  7     6      .4410      .0230    13.0140     1.4420
30 URBAN CORE   810229 12  7     7      .0040      .0020      .0005      .0010
30 URBAN CORE   810229 12  7     8      .0510      .0070      .2880      .0680
30 URBAN CORE   810229 12  7     9      .0030      .0020      .0150      .0030
30 URBAN CORE   810229 12  7    10      .0020      .0040      .0220      .0050
30 URBAN CORE   810229 12  7    11      .0130      .0020      .0180      .0020
30 URBAN CORE   810229 12  7    12      .2080      .0110     1.8710      .1180
30 URBAN CORE   810229 12  7    13      .0000      .0030      .0010      .0020
30 URBAN CORE   810229 12  7    14      .1650      .0090      .5170      .0720
30 URBAN CORE   810229 12  7    15      .0220      .0040      .0880      .0080
30 URBAN CORE   810229 12  7    16      .0060      .0010      .0030      .0010
30 URBAN CORE   810229 12  7    17      .1190      .0170      .1020      .0400
30 URBAN CORE   810229 12  7    18     1.4220      .0680      .3460      .0240
30 URBAN CORE   810229 12  7    19    13.1300      .6810     1.7250      .9390
30 URBAN CORE   810229 12  7    20      .0030      .0020      .0040      .0020
30 URBAN CORE   810229 12  7    21      .2770      .0310     8.6520     1.9870
30 URBAN CORE   810229 12  7    22      .0010      .0020      .0050      .0020
30 URBAN CORE   810229 12  7    23      .0030      .0010      .0300      .0030
30 URBAN CORE   810229 12  7    24      .0070      .0140      .2050      .0370
30 URBAN CORE   810229 12  7    25      .0020      .0080      .0070      .0140
30 URBAN CORE   810229 12  7    26      .0420      .0030      .0710      .0060
 3 URBAN CORE   810229 12  7    12
30 URBAN CORE   810229 12  7     1    35.0000     7.0000    75.0000     7.0000
30 URBAN CORE   810229 12  7     2      .0880      .0620     1.9510      .4220
30 URBAN CORE   810229 12  7     3      .0360      .0070      .0040      .0040
30 URBAN CORE   810229 12  7     4      .1490      .0140      .3710      .0230
30 URBAN CORE   810229 12  7     5      .3440      .0170      .1080      .0070
30 URBAN CORE   810229 12  7     6      .4410      .0230    13.0140     1.4420
30 URBAN CORE   810229 12  7     7      .0040      .0020      .0005      .0010
30 URBAN CORE   810229 12  7     8      .0510      .0070      .2880      .0680
30 URBAN CORE   810229 12  7     9      .0030      .0020      .0150      .0030
30 URBAN CORE   810229 12  7    10      .0020      .0040      .0220      .0050
30 URBAN CORE   810229 12  7    11      .0130      .0020      .0180      .0020
30 URBAN CORE   810229 12  7    12      .2080      .0110     1.8710      .1180
30 URBAN CORE   810229 12  7    13      .0000      .0030      .0010      .0020
30 URBAN CORE   810229 12  7    14      .1650      .0090      .5170      .0720
30 URBAN CORE   810229 12  7    15      .0220      .0040      .0880      .0080
30 URBAN CORE   810229 12  7    16      .0060      .0010      .0030      .0010
30 URBAN CORE   810229 12  7    17      .1190      .0170      .1020      .0400
```

TABLE C-8 (CONTINUED)

30	URBAN CORE	810229	12	7		18	1.4220	.0680	.3460	.0240
30	URBAN CORE	810229	12	7		19	13.1300	.6810	1.7250	.9390
30	URBAN CORE	810229	12	7		20	.0030	.0020	.0040	.0020
30	URBAN CORE	810229	12	7		21	.2770	.0310	8.6520	1.9870
30	URBAN CORE	810229	12	7		22	.0010	.0020	.0050	.0020
30	URBAN CORE	810229	12	7		23	.0030	.0010	.0300	.0030
30	URBAN CORE	810229	12	7		24	.0070	.0140	.2050	.0370
30	URBAN CORE	810229	12	7		25	.0020	.0080	.0070	.0140
30	URBAN CORE	810229	12	7		26	.0420	.0030	.0710	.0060
40	URBAN CORE	810229	12	7	1	1	-.5088	3.0917	36.4449	18.7516
40	URBAN CORE	810229	12	7	1	2	-.0033	.0207	.2004	.1175
40	URBAN CORE	810229	12	7	1	6	-.0473	.2966	1.8587	1.0898
40	URBAN CORE	810229	12	7	1	11	-.0002	.0010	.0033	.0019
40	URBAN CORE	810229	12	7	1	12	-.0042	.0265	.1749	.1026
40	URBAN CORE	810229	12	7	1	14	-.0010	.0064	.0437	.0256
40	URBAN CORE	810229	12	7	1	15	-.0002	.0012	.0077	.0045
40	URBAN CORE	810229	12	7	1	18	-.0001	.0004	.0073	.0043
40	URBAN CORE	810229	12	7	1	19	-.0023	.0144	.0984	.0577
40	URBAN CORE	810229	12	7	1	21	-.0122	.0765	.8747	.5128
40	URBAN CORE	810229	12	7	1	23	-.0001	.0009	.0051	.0030
40	URBAN CORE	810229	12	7	1	24	-.0007	.0045	.0324	.0190
40	URBAN CORE	810229	12	7	1	26	-.0001	.0007	.0033	.0019
40	URBAN CORE	810229	12	7	1	30	.0000	.0001	.0007	.0004
40	URBAN CORE	810229	12	7	2	1	-.0244	.9225	13.5780	6.1852
40	URBAN CORE	810229	12	7	2	2	-.0022	.0841	.8948	.4760
40	URBAN CORE	810229	12	7	2	5	.0000	.0002	.0011	.0006
40	URBAN CORE	810229	12	7	2	6	-.0006	.0232	.4073	.2167
40	URBAN CORE	810229	12	7	2	10	.0000	.0004	.0000	.0000
40	URBAN CORE	810229	12	7	2	11	.0000	.0003	.0000	.0000
40	URBAN CORE	810229	12	7	2	12	-.0015	.0571	.7780	.4139
40	URBAN CORE	810229	12	7	2	14	-.0003	.0098	.0000	.0000
40	URBAN CORE	810229	12	7	2	15	.0000	.0012	.0136	.0072
40	URBAN CORE	810229	12	7	2	16	.0000	.0001	.0000	.0000
40	URBAN CORE	810229	12	7	2	18	-.0001	.0035	.0000	.0000
40	URBAN CORE	810229	12	7	2	19	-.0003	.0106	.0000	.0000
40	URBAN CORE	810229	12	7	2	21	-.0054	.2121	3.8561	2.0513
40	URBAN CORE	810229	12	7	2	24	-.0002	.0061	.1371	.0730
40	URBAN CORE	810229	12	7	2	25	.0000	.0002	.0037	.0020
40	URBAN CORE	810229	12	7	2	26	.0000	.0010	.0000	.0000
40	URBAN CORE	810229	12	7	2	27	-.0033	.1298	.6640	.3532
40	URBAN CORE	810229	12	7	2	28	-.0003	.0119	.2376	.1264
40	URBAN CORE	810229	12	7	2	29	.0000	.0000	.0027	.0014
40	URBAN CORE	810229	12	7	3	1	-.4464	.1712	.1769	.4910
40	URBAN CORE	810229	12	7	3	6	-.0045	.0021	.0018	.0051
40	URBAN CORE	810229	12	7	3	8	-.2455	.1148	.0973	.2794
40	URBAN CORE	810229	12	7	3	14	-.0045	.0021	.0018	.0051
40	URBAN CORE	810229	12	7	3	19	-.0402	.0188	.0159	.0457

TABLE C-8 (CONTINUED)

40	URBAN CORE	810229	12	7	3	28	-.1384	.0647	.0548	.1575
40	URBAN CORE	810229	12	7	5	1	7.3772	20.4363	10.3394	13.6553
40	URBAN CORE	810229	12	7	5	2	.0089	.0254	.0124	.0172
40	URBAN CORE	810229	12	7	5	6	.0125	.0359	.0176	.0243
40	URBAN CORE	810229	12	7	5	11	.0018	.0051	.0025	.0034
40	URBAN CORE	810229	12	7	5	12	.0081	.0233	.0114	.0157
40	URBAN CORE	810229	12	7	5	14	.0032	.0093	.0045	.0063
40	URBAN CORE	810229	12	7	5	15	.0011	.0032	.0016	.0021
40	URBAN CORE	810229	12	7	5	16	.0011	.0032	.0016	.0021
40	URBAN CORE	810229	12	7	5	19	3.6886	10.5729	5.1697	7.1555
40	URBAN CORE	810229	12	7	5	21	.0376	.1078	.0527	.0730
40	URBAN CORE	810229	12	7	5	26	.0059	.0169	.0083	.0114
40	URBAN CORE	810229	12	7	5	27	2.8771	8.2469	4.0324	5.5813
40	URBAN CORE	810229	12	7	6	1	4.6355	.9405	.7224	.2752
40	URBAN CORE	810229	12	7	6	2	.0020	.0007	.0003	.0001
40	URBAN CORE	810229	12	7	6	5	.3801	.1239	.0592	.0276
40	URBAN CORE	810229	12	7	6	8	.2503	.0816	.0390	.0182
40	URBAN CORE	810229	12	7	6	11	.0002	.0001	.0000	.0000
40	URBAN CORE	810229	12	7	6	12	.0116	.0038	.0018	.0008
40	URBAN CORE	810229	12	7	6	18	.9781	.3188	.1524	.0710
40	URBAN CORE	810229	12	7	6	19	.0097	.0032	.0015	.0007
40	URBAN CORE	810229	12	7	6	21	.0035	.0011	.0005	.0003
40	URBAN CORE	810229	12	7	6	26	.0010	.0003	.0002	.0001
40	URBAN CORE	810229	12	7	6	27	2.5263	.8235	.3937	.1833
40	URBAN CORE	810229	12	7	9	1	3.5958	6.6142	.0000	.0000
40	URBAN CORE	810229	12	7	9	2	.0111	.0213	.0000	.0000
40	URBAN CORE	810229	12	7	9	5	.0009	.0018	.0000	.0000
40	URBAN CORE	810229	12	7	9	6	.0180	.0344	.0000	.0000
40	URBAN CORE	810229	12	7	9	8	.0431	.0825	.0000	.0000
40	URBAN CORE	810229	12	7	9	11	.0061	.0117	.0000	.0000
40	URBAN CORE	810229	12	7	9	12	.0043	.0083	.0000	.0000
40	URBAN CORE	810229	12	7	9	14	.0006	.0012	.0000	.0000
40	URBAN CORE	810229	12	7	9	15	.0005	.0010	.0000	.0000
40	URBAN CORE	810229	12	7	9	16	.0003	.0006	.0000	.0000
40	URBAN CORE	810229	12	7	9	18	.0194	.0371	.0000	.0000
40	URBAN CORE	810229	12	7	9	19	.4746	.9077	.0000	.0000
40	URBAN CORE	810229	12	7	9	21	.0097	.0186	.0000	.0000
40	URBAN CORE	810229	12	7	9	25	.0002	.0003	.0000	.0000
40	URBAN CORE	810229	12	7	9	26	.0010	.0020	.0000	.0000
40	URBAN CORE	810229	12	7	9	27	1.2873	2.4619	.0000	.0000
40	URBAN CORE	810229	12	7	9	28	.0115	.0220	.0000	.0000
40	URBAN CORE	810229	12	7	9	29	.0360	.0688	.0000	.0000
40	URBAN CORE	810229	12	7	10	1	1.0147	5.3113	.0000	.0000
40	URBAN CORE	810229	12	7	10	6	.0507	.2740	.0000	.0000
40	URBAN CORE	810229	12	7	10	19	.4769	2.5759	.0000	.0000

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TABLE C-8 (CONTINUED)

40	URBAN CORE	810229	12	7	10	27	.1218	.6577	.0000	.0000
40	URBAN CORE	810229	12	7	11	1	1.7708	1.3477	4.5322	3.1369
40	URBAN CORE	810229	12	7	11	2	.0078	.0064	.0000	.0000
40	URBAN CORE	810229	12	7	11	4	.0002	.0002	.0000	.0000
40	URBAN CORE	810229	12	7	11	6	.0322	.0265	.1070	.0809
40	URBAN CORE	810229	12	7	11	7	.0016	.0013	.0000	.0000
40	URBAN CORE	810229	12	7	11	10	.0003	.0002	.0000	.0000
40	URBAN CORE	810229	12	7	11	11	.0004	.0003	.0000	.0000
40	URBAN CORE	810229	12	7	11	12	.0767	.0632	.1858	.1404
40	URBAN CORE	810229	12	7	11	14	.0033	.0028	.0000	.0000
40	URBAN CORE	810229	12	7	11	16	.0001	.0001	.0000	.0000
40	URBAN CORE	810229	12	7	11	18	.0118	.0098	.0000	.0000
40	URBAN CORE	810229	12	7	11	19	.1705	.1404	.5489	.4150
40	URBAN CORE	810229	12	7	11	20	.0005	.0004	.0000	.0000
40	URBAN CORE	810229	12	7	11	21	.0630	.0518	.1492	.1128
40	URBAN CORE	810229	12	7	11	22	.0146	.0120	.0000	.0000
40	URBAN CORE	810229	12	7	11	24	.0021	.0018	.0000	.0000
40	URBAN CORE	810229	12	7	11	26	.0288	.0237	.0310	.0234
40	URBAN CORE	810229	12	7	11	28	.0043	.0035	.0000	.0000
40	URBAN CORE	810229	12	7	12	1	.0000	.0000	2.2289	3.4552
40	URBAN CORE	810229	12	7	12	2	.0000	.0000	.0062	.0101
40	URBAN CORE	810229	12	7	12	5	.0000	.0000	.0012	.0020
40	URBAN CORE	810229	12	7	12	6	.0000	.0000	.0080	.0130
40	URBAN CORE	810229	12	7	12	8	.0000	.0000	.0646	.1045
40	URBAN CORE	810229	12	7	12	10	.0000	.0000	.0107	.0173
40	URBAN CORE	810229	12	7	12	11	.0000	.0000	.0013	.0022
40	URBAN CORE	810229	12	7	12	12	.0000	.0000	.0410	.0663
40	URBAN CORE	810229	12	7	12	14	.0000	.0000	.0089	.0144
40	URBAN CORE	810229	12	7	12	15	.0000	.0000	.0012	.0019
40	URBAN CORE	810229	12	7	12	16	.0000	.0000	.0049	.0079
40	URBAN CORE	810229	12	7	12	19	.0000	.0000	.2630	.4254
40	URBAN CORE	810229	12	7	12	21	.0000	.0000	.0029	.0047
40	URBAN CORE	810229	12	7	12	27	.0000	.0000	.3923	.6345
40	URBAN CORE	810229	12	7	12	28	.0000	.0000	.1181	.1911
40	URBAN CORE	810229	12	7	13	1	.0763	.4535	.0000	.0000
40	URBAN CORE	810229	12	7	13	2	.0005	.0030	.0000	.0000
40	URBAN CORE	810229	12	7	13	6	.0047	.0290	.0000	.0000
40	URBAN CORE	810229	12	7	13	8	.0014	.0087	.0000	.0000
40	URBAN CORE	810229	12	7	13	10	.0016	.0098	.0000	.0000
40	URBAN CORE	810229	12	7	13	11	.0002	.0013	.0000	.0000
40	URBAN CORE	810229	12	7	13	12	.0244	.1495	.0000	.0000
40	URBAN CORE	810229	12	7	13	14	.0007	.0043	.0000	.0000
40	URBAN CORE	810229	12	7	13	15	.0066	.0407	.0000	.0000

TABLE C-8 (CONTINUED)

40	URBAN CORE	810229	12	7	13	16	.0005	.0033	.0000	.0000
40	URBAN CORE	810229	12	7	13	18	.0006	.0036	.0000	.0000
40	URBAN CORE	810229	12	7	13	19	.0019	.0117	.0000	.0000
40	URBAN CORE	810229	12	7	13	21	.0038	.0234	.0000	.0000
40	URBAN CORE	810229	12	7	13	24	.0002	.0009	.0000	.0000
40	URBAN CORE	810229	12	7	13	25	.0000	.0003	.0000	.0000
40	URBAN CORE	810229	12	7	13	26	.0009	.0056	.0000	.0000
40	URBAN CORE	810229	12	7	13	28	.0010	.0059	.0000	.0000
40	URBAN CORE	810229	12	7	14	1	.0605	.2501	.0000	.0000
40	URBAN CORE	810229	12	7	14	2	.0004	.0017	.0000	.0000
40	URBAN CORE	810229	12	7	14	5	.0001	.0004	.0000	.0000
40	URBAN CORE	810229	12	7	14	6	.0008	.0034	.0000	.0000
40	URBAN CORE	810229	12	7	14	8	.0003	.0011	.0000	.0000
40	URBAN CORE	810229	12	7	14	10	.0000	.0001	.0000	.0000
40	URBAN CORE	810229	12	7	14	11	.0000	.0001	.0000	.0000
40	URBAN CORE	810229	12	7	14	12	.0013	.0054	.0000	.0000
40	URBAN CORE	810229	12	7	14	14	.0064	.0271	.0000	.0000
40	URBAN CORE	810229	12	7	14	15	.0105	.0447	.0000	.0000
40	URBAN CORE	810229	12	7	14	18	.0000	.0001	.0000	.0000
40	URBAN CORE	810229	12	7	14	19	.0025	.0108	.0000	.0000
40	URBAN CORE	810229	12	7	14	21	.0006	.0026	.0000	.0000
40	URBAN CORE	810229	12	7	14	24	.0000	.0001	.0000	.0000
40	URBAN CORE	810229	12	7	14	25	.0000	.0001	.0000	.0000
40	URBAN CORE	810229	12	7	14	26	.0004	.0015	.0000	.0000
40	URBAN CORE	810229	12	7	14	27	.0064	.0271	.0000	.0000
40	URBAN CORE	810229	12	7	14	28	.0019	.0080	.0000	.0000
40	URBAN CORE	810229	12	7	14	29	.0034	.0147	.0000	.0000
40	URBAN CORE	810229	12	7	16	1	7.4027	2.9194	13.8741	11.3240
40	URBAN CORE	810229	12	7	16	6	.3701	.1766	2.7748	2.4354
40	URBAN CORE	810229	12	7	16	14	.1481	.0707	.2775	.2435
40	URBAN CORE	810229	12	7	16	19	4.4416	2.1197	.4162	.3653
40	URBAN CORE	810229	12	7	16	21	.1851	.0883	1.3874	1.2177
40	URBAN CORE	810229	12	7	16	27	.5922	.2826	2.6361	2.3136
40	URBAN CORE	810229	12	7	17	1	8.2208	12.2522	.0000	.0000
40	URBAN CORE	810229	12	7	17	12	.0822	.1280	.0000	.0000
40	URBAN CORE	810229	12	7	17	19	4.1104	6.3977	.0000	.0000
40	URBAN CORE	810229	12	7	17	27	.3288	.5118	.0000	.0000
40	URBAN CORE	810229	12	7	19	1	-.1872	11.0124	.0000	.0000
40	URBAN CORE	810229	12	7	19	19	-.1872	11.0124	.0000	.0000
3	BACKGROUND	810229	12	7		12				
30	BACKGROUND	810229	12	7		1	28.0000	3.0000	37.0000	4.0000
30	BACKGROUND	810229	12	7		2	.0700	.0550	.7390	.1710
30	BACKGROUND	810229	12	7		3	.0140	.0060	.0010	.0040
30	BACKGROUND	810229	12	7		4	.1460	.0180	.0860	.0160

TABLE C-8 (CONTINUED)

30	BACKGROUND	810229	12	7		5	.1640	.0100	.0640	.0050
30	BACKGROUND	810229	12	7		6	.1280	.0080	3.8050	.4440
30	BACKGROUND	810229	12	7		7	.0010	.0020	.0010	.0020
30	BACKGROUND	810229	12	7		8	.0100	.0070	.0140	.0100
30	BACKGROUND	810229	12	7		9	.0080	.0030	.0010	.0030
30	BACKGROUND	810229	12	7		10	.0100	.0050	.0025	.0050
30	BACKGROUND	810229	12	7		11	.0270	.0030	.0040	.0020
30	BACKGROUND	810229	12	7		12	.1200	.0080	.6920	.0440
30	BACKGROUND	810229	12	7		13	.0015	.0030	.0090	.0030
30	BACKGROUND	810229	12	7		14	.1860	.0100	.2150	.0320
30	BACKGROUND	810229	12	7		15	.0220	.0040	.0180	.0040
30	BACKGROUND	810229	12	7		16	.0030	.0020	.0010	.0020
30	BACKGROUND	810229	12	7		17	.1030	.0180	.0200	.0220
30	BACKGROUND	810229	12	7		18	.8940	.0470	.2130	.0170
30	BACKGROUND	810229	12	7		19	14.7800	.7650	.8520	.7830
30	BACKGROUND	810229	12	7		20	.0080	.0030	.0010	.0030
30	BACKGROUND	810229	12	7		21	.1890	.0270	4.0000	.9140
30	BACKGROUND	810229	12	7		22	.0240	.0030	.0030	.0030
30	BACKGROUND	810229	12	7		23	.0030	.0020	.0060	.0020
30	BACKGROUND	810229	12	7		24	.0080	.0160	.0970	.0170
30	BACKGROUND	810229	12	7		25	.0030	.0090	.0035	.0070
30	BACKGROUND	810229	12	7		26	.0380	.0030	.0160	.0030
40	BACKGROUND	810229	12	7	1	1	-.3337	.3463	20.2530	5.8613
40	BACKGROUND	810229	12	7	1	2	-.0022	.0024	.1114	.0434
40	BACKGROUND	810229	12	7	1	6	-.0310	.0341	1.0329	.4020
40	BACKGROUND	810229	12	7	1	11	-.0001	.0001	.0018	.0007
40	BACKGROUND	810229	12	7	1	12	-.0028	.0030	.0972	.0378
40	BACKGROUND	810229	12	7	1	14	-.0007	.0007	.0243	.0095
40	BACKGROUND	810229	12	7	1	15	-.0001	.0001	.0043	.0017
40	BACKGROUND	810229	12	7	1	18	.0000	.0001	.0041	.0016
40	BACKGROUND	810229	12	7	1	19	-.0015	.0016	.0547	.0213
40	BACKGROUND	810229	12	7	1	21	-.0080	.0088	.4861	.1892
40	BACKGROUND	810229	12	7	1	23	-.0001	.0001	.0028	.0011
40	BACKGROUND	810229	12	7	1	24	-.0005	.0005	.0180	.0070
40	BACKGROUND	810229	12	7	1	26	-.0001	.0001	.0018	.0007
40	BACKGROUND	810229	12	7	1	30	.0000	.0000	.0004	.0002
40	BACKGROUND	810229	12	7	2	1	.2138	.6555	6.1296	1.3633
40	BACKGROUND	810229	12	7	2	2	.0189	.0599	.4039	.1370
40	BACKGROUND	810229	12	7	2	5	.0000	.0001	.0005	.0002
40	BACKGROUND	810229	12	7	2	6	.0052	.0165	.1839	.0624
40	BACKGROUND	810229	12	7	2	10	.0001	.0003	.0000	.0000
40	BACKGROUND	810229	12	7	2	11	.0001	.0002	.0000	.0000
40	BACKGROUND	810229	12	7	2	12	.0128	.0407	.3512	.1191
40	BACKGROUND	810229	12	7	2	14	.0022	.0070	.0000	.0000
40	BACKGROUND	810229	12	7	2	15	.0003	.0008	.0061	.0021
40	BACKGROUND	810229	12	7	2	16	.0000	.0001	.0000	.0000
40	BACKGROUND	810229	12	7	2	18	.0008	.0025	.0000	.0000
40	BACKGROUND	810229	12	7	2	19	.0024	.0075	.0000	.0000

TABLE C-8 (CONTINUED)

40	BACKGROUND	810229	12	7	2	21	.0477	.1512	1.7408	.5905
40	BACKGROUND	810229	12	7	2	24	.0014	.0043	.0619	.0210
40	BACKGROUND	810229	12	7	2	25	.0000	.0002	.0017	.0006
40	BACKGROUND	810229	12	7	2	26	.0002	.0007	.0000	.0000
40	BACKGROUND	810229	12	7	2	27	.0292	.0925	.2997	.1017
40	BACKGROUND	810229	12	7	2	28	.0027	.0085	.1073	.0364
40	BACKGROUND	810229	12	7	2	29	.0000	.0000	.0012	.0004
40	BACKGROUND	810229	12	7	3	1	-.1872	.0933	-.0240	.0311
40	BACKGROUND	810229	12	7	3	6	-.0019	.0011	-.0002	.0003
40	BACKGROUND	810229	12	7	3	8	-.1029	.0588	-.0132	.0179
40	BACKGROUND	810229	12	7	3	14	-.0019	.0011	-.0002	.0003
40	BACKGROUND	810229	12	7	3	19	-.0168	.0096	-.0022	.0029
40	BACKGROUND	810229	12	7	3	28	-.0580	.0332	-.0074	.0101
40	BACKGROUND	810229	12	7	5	1	12.5377	7.3249	1.7490	4.8223
40	BACKGROUND	810229	12	7	5	2	.0150	.0098	.0021	.0060
40	BACKGROUND	810229	12	7	5	6	.0213	.0139	.0030	.0085
40	BACKGROUND	810229	12	7	5	11	.0030	.0020	.0004	.0012
40	BACKGROUND	810229	12	7	5	12	.0138	.0090	.0019	.0055
40	BACKGROUND	810229	12	7	5	14	.0055	.0036	.0008	.0022
40	BACKGROUND	810229	12	7	5	15	.0019	.0012	.0003	.0007
40	BACKGROUND	810229	12	7	5	16	.0019	.0012	.0003	.0007
40	BACKGROUND	810229	12	7	5	19	6.2689	4.0875	.8745	2.4949
40	BACKGROUND	810229	12	7	5	21	.0639	.0417	.0089	.0254
40	BACKGROUND	810229	12	7	5	26	.0100	.0065	.0014	.0040
40	BACKGROUND	810229	12	7	5	27	4.8897	3.1883	.6821	1.9461
40	BACKGROUND	810229	12	7	6	1	1.8886	.6088	.5401	.1058
40	BACKGROUND	810229	12	7	6	2	.0008	.0003	.0002	.0001
40	BACKGROUND	810229	12	7	6	5	.1549	.0644	.0443	.0142
40	BACKGROUND	810229	12	7	6	8	.1020	.0424	.0292	.0094
40	BACKGROUND	810229	12	7	6	11	.0001	.0000	.0000	.0000
40	BACKGROUND	810229	12	7	6	12	.0047	.0020	.0014	.0004
40	BACKGROUND	810229	12	7	6	18	.3985	.1657	.1140	.0366
40	BACKGROUND	810229	12	7	6	19	.0040	.0016	.0011	.0004
40	BACKGROUND	810229	12	7	6	21	.0014	.0006	.0004	.0001
40	BACKGROUND	810229	12	7	6	26	.0004	.0002	.0001	.0000
40	BACKGROUND	810229	12	7	6	27	1.0293	.4280	.2943	.0946
40	BACKGROUND	810229	12	7	9	1	1.5719	3.7865	.0000	.0000
40	BACKGROUND	810229	12	7	9	2	.0049	.0122	.0000	.0000
40	BACKGROUND	810229	12	7	9	5	.0004	.0010	.0000	.0000
40	BACKGROUND	810229	12	7	9	6	.0079	.0196	.0000	.0000
40	BACKGROUND	810229	12	7	9	8	.0189	.0471	.0000	.0000
40	BACKGROUND	810229	12	7	9	11	.0027	.0067	.0000	.0000

TABLE C-8 (CONTINUED)

40	BACKGROUND	810229	12	7	9	12	.0019	.0047	.0000	.0000
40	BACKGROUND	810229	12	7	9	14	.0003	.0007	.0000	.0000
40	BACKGROUND	810229	12	7	9	15	.0002	.0005	.0000	.0000
40	BACKGROUND	810229	12	7	9	16	.0001	.0004	.0000	.0000
40	BACKGROUND	810229	12	7	9	18	.0085	.0212	.0000	.0000
40	BACKGROUND	810229	12	7	9	19	.2075	.5178	.0000	.0000
40	BACKGROUND	810229	12	7	9	21	.0042	.0106	.0000	.0000
40	BACKGROUND	810229	12	7	9	25	.0001	.0002	.0000	.0000
40	BACKGROUND	810229	12	7	9	26	.0005	.0011	.0000	.0000
40	BACKGROUND	810229	12	7	9	27	.5628	1.4043	.0000	.0000
40	BACKGROUND	810229	12	7	9	28	.0050	.0126	.0000	.0000
40	BACKGROUND	810229	12	7	9	29	.0157	.0392	.0000	.0000
40	BACKGROUND	810229	12	7	10	1	-.7351	.7328	.0000	.0000
40	BACKGROUND	810229	12	7	10	6	-.0368	.0389	.0000	.0000
40	BACKGROUND	810229	12	7	10	19	-.3455	.3654	.0000	.0000
40	BACKGROUND	810229	12	7	10	27	-.0882	.0933	.0000	.0000
40	BACKGROUND	810229	12	7	11	1	1.0883	.9506	1.3968	.8400
40	BACKGROUND	810229	12	7	11	2	.0048	.0045	.0000	.0000
40	BACKGROUND	810229	12	7	11	4	.0001	.0001	.0000	.0000
40	BACKGROUND	810229	12	7	11	6	.0198	.0185	.0330	.0220
40	BACKGROUND	810229	12	7	11	7	.0010	.0009	.0000	.0000
40	BACKGROUND	810229	12	7	11	10	.0002	.0002	.0000	.0000
40	BACKGROUND	810229	12	7	11	11	.0002	.0002	.0000	.0000
40	BACKGROUND	810229	12	7	11	12	.0472	.0441	.0573	.0383
40	BACKGROUND	810229	12	7	11	14	.0021	.0019	.0000	.0000
40	BACKGROUND	810229	12	7	11	16	.0001	.0001	.0000	.0000
40	BACKGROUND	810229	12	7	11	18	.0073	.0068	.0000	.0000
40	BACKGROUND	810229	12	7	11	19	.1048	.0979	.1692	.1131
40	BACKGROUND	810229	12	7	11	20	.0003	.0003	.0000	.0000
40	BACKGROUND	810229	12	7	11	21	.0387	.0362	.0460	.0307
40	BACKGROUND	810229	12	7	11	22	.0090	.0084	.0000	.0000
40	BACKGROUND	810229	12	7	11	24	.0013	.0012	.0000	.0000
40	BACKGROUND	810229	12	7	11	26	.0177	.0165	.0095	.0064
40	BACKGROUND	810229	12	7	11	28	.0026	.0025	.0000	.0000
40	BACKGROUND	810229	12	7	12	1	.0000	.0000	.0531	.5375
40	BACKGROUND	810229	12	7	12	2	.0000	.0000	.0001	.0016
40	BACKGROUND	810229	12	7	12	5	.0000	.0000	.0000	.0003
40	BACKGROUND	810229	12	7	12	6	.0000	.0000	.0002	.0020
40	BACKGROUND	810229	12	7	12	8	.0000	.0000	.0015	.0161
40	BACKGROUND	810229	12	7	12	10	.0000	.0000	.0003	.0027
40	BACKGROUND	810229	12	7	12	11	.0000	.0000	.0000	.0003
40	BACKGROUND	810229	12	7	12	12	.0000	.0000	.0010	.0102
40	BACKGROUND	810229	12	7	12	14	.0000	.0000	.0002	.0022
40	BACKGROUND	810229	12	7	12	15	.0000	.0000	.0000	.0003
40	BACKGROUND	810229	12	7	12	16	.0000	.0000	.0001	.0012
40	BACKGROUND	810229	12	7	12	19	.0000	.0000	.0063	.0654

TABLE C-8 (CONTINUED)

40	BACKGROUND	810229	12	7	12	21	.0000	.0000	.0001	.0007
40	BACKGROUND	810229	12	7	12	27	.0000	.0000	.0093	.0975
40	BACKGROUND	810229	12	7	12	28	.0000	.0000	.0028	.0294
40	BACKGROUND	810229	12	7	13	1	-.0525	.1141	.0000	.0000
40	BACKGROUND	810229	12	7	13	2	-.0003	.0008	.0000	.0000
40	BACKGROUND	810229	12	7	13	6	-.0033	.0073	.0000	.0000
40	BACKGROUND	810229	12	7	13	8	-.0010	.0022	.0000	.0000
40	BACKGROUND	810229	12	7	13	10	-.0011	.0025	.0000	.0000
40	BACKGROUND	810229	12	7	13	11	-.0001	.0003	.0000	.0000
40	BACKGROUND	810229	12	7	13	12	-.0168	.0378	.0000	.0000
40	BACKGROUND	810229	12	7	13	14	-.0005	.0011	.0000	.0000
40	BACKGROUND	810229	12	7	13	15	-.0046	.0103	.0000	.0000
40	BACKGROUND	810229	12	7	13	16	-.0004	.0008	.0000	.0000
40	BACKGROUND	810229	12	7	13	18	-.0004	.0009	.0000	.0000
40	BACKGROUND	810229	12	7	13	19	-.0013	.0030	.0000	.0000
40	BACKGROUND	810229	12	7	13	21	-.0026	.0059	.0000	.0000
40	BACKGROUND	810229	12	7	13	24	-.0001	.0002	.0000	.0000
40	BACKGROUND	810229	12	7	13	25	.0000	.0001	.0000	.0000
40	BACKGROUND	810229	12	7	13	26	-.0006	.0014	.0000	.0000
40	BACKGROUND	810229	12	7	13	28	-.0007	.0015	.0000	.0000
40	BACKGROUND	810229	12	7	14	1	.1465	.1368	.0000	.0000
40	BACKGROUND	810229	12	7	14	2	.0009	.0009	.0000	.0000
40	BACKGROUND	810229	12	7	14	5	.0002	.0002	.0000	.0000
40	BACKGROUND	810229	12	7	14	6	.0019	.0019	.0000	.0000
40	BACKGROUND	810229	12	7	14	8	.0006	.0006	.0000	.0000
40	BACKGROUND	810229	12	7	14	10	.0001	.0001	.0000	.0000
40	BACKGROUND	810229	12	7	14	11	.0001	.0001	.0000	.0000
40	BACKGROUND	810229	12	7	14	12	.0031	.0031	.0000	.0000
40	BACKGROUND	810229	12	7	14	14	.0154	.0153	.0000	.0000
40	BACKGROUND	810229	12	7	14	15	.0254	.0252	.0000	.0000
40	BACKGROUND	810229	12	7	14	18	.0001	.0001	.0000	.0000
40	BACKGROUND	810229	12	7	14	19	.0062	.0061	.0000	.0000
40	BACKGROUND	810229	12	7	14	21	.0015	.0014	.0000	.0000
40	BACKGROUND	810229	12	7	14	24	.0001	.0001	.0000	.0000
40	BACKGROUND	810229	12	7	14	25	.0000	.0000	.0000	.0000
40	BACKGROUND	810229	12	7	14	26	.0008	.0008	.0000	.0000
40	BACKGROUND	810229	12	7	14	27	.0154	.0153	.0000	.0000
40	BACKGROUND	810229	12	7	14	28	.0045	.0045	.0000	.0000
40	BACKGROUND	810229	12	7	14	29	.0084	.0083	.0000	.0000
40	BACKGROUND	810229	12	7	16	1	2.8841	1.1658	6.9544	2.6936
40	BACKGROUND	810229	12	7	16	6	.1442	.0701	1.3909	.6552
40	BACKGROUND	810229	12	7	16	14	.0577	.0280	.1391	.0655
40	BACKGROUND	810229	12	7	16	19	1.7305	.8408	.2086	.0983
40	BACKGROUND	810229	12	7	16	21	.0721	.0350	.6954	.3276

TABLE C-8 (CONTINUED)

40	BACKGROUND	810229	12	7	16	27	.2307	.1121	1.3213	.6224
40	BACKGROUND	810229	12	7	17	1	4.5964	4.5043	.0000	.0000
40	BACKGROUND	810229	12	7	17	12	.0460	.0478	.0000	.0000
40	BACKGROUND	810229	12	7	17	19	2.2982	2.3915	.0000	.0000
40	BACKGROUND	810229	12	7	17	27	.1839	.1913	.0000	.0000
40	BACKGROUND	810229	12	7	19	1	4.0254	4.4807	.0000	.0000
40	BACKGROUND	810229	12	7	19	19	4.0254	4.4807	.0000	.0000

APPENDIX D

STATISTICAL APPROACH FOR SOURCE APPORTIONMENT

This appendix presents a discussion of the statistical methods used in the source apportionment software documented herein. First, the source apportionment problem is formulated in mathematical terms. This involves primarily stating the mass balance equations used in source apportionment.

Subsequently a discussion of the statistical methods used in the software documented herein is presented. The basic approach used is regression analysis. However, several additional features are available to handle specific aspects of the problem.

While Section 2 discusses source apportionment strictly from a user's viewpoint, this appendix discusses the mathematics, with references to papers which provide further detail. For the convenience of the reader, Section 2 and this appendix have both been made as nearly self-contained as is feasible. As a result, some overlap exists between the two discussions.

Mathematical Formulation of the Problem

The standard equation used in CMB analysis is as follows:

$$C_i = \sum_{j=1}^{m} F_{ij} S_j \tag{1}$$

where

C_i is the ambient particulate concentration of species i,

F_{ij} is the fraction of the particulate matter emitted from source j comprised of species i,

S_j is the ambient particulate concentration resulting from source j, and

m is the number of sources.

All inputs pertain to the size fraction being considered.

The C_i values are obtained through chemical analysis of ambient particulate samples. The F_{ij} values are obtained through direct source characterization or by indirect methods, such as sampling upwind and downwind of a source. The C_i and F_{ij} values are required inputs. Depending on the type of statistical analysis performed, the standard errors of the C_i and F_{ij} values may also be included. The "standard error" of a quantity is the standard deviation of its random error. The values of S_j represent the contributions of the different sources to the ambient particulate concentration, and, as such, are the unknown values.

If multiple particulate samples have been collected for a specific set of conditions, averaging can be performed to produce a single concentration for each species. Subsequently, a single CMB analysis can be performed using the averaged concentrations. An alternative is to perform a separate CMB analysis for each particulate sample and then average the CMB results for each source. In this case, however, the error present in the source signature (F_{ij}) matrix would be common to all periods. Thus, the separate CMB analyses would have correlated errors. For this reason, the conventional standard error of the mean would have a low bias (see the discussion of this point in Section 2).

At the option of the user, an intercept term S_o can be added to the standard equation:

$$C_i = S_o + \sum_{j=1}^{m} F_{ij}S_j \qquad (2)$$

The intercept represents a part of the particulate concentration not accounted for by the m sources considered. Thus, the intercept should be zero within random error unless there is a significant source which has not been considered or large data errors exist. The intercept provides a check on the closure of the mass balance equations. If the regression is performed with no intercept, all variances are computed about zero, not about the mean values.

An additional equation can also be employed:

$$C_T = S_o + \sum_{j=1}^{m} S_j \tag{3}$$

where C_T is the measured aerosol mass concentration for the size fraction being considered. This equation simply states that the sum of the intercept and the particulate concentrations attributable to the m sources equals the ambient aerosol mass concentration. The intercept here is again the particulate concentration not explainable by any of the sources considered. Thus, as before, the intercept should be near zero unless there is a significant omitted source or large data errors.

Statistical Approaches

Regression analysis is the basic statistical approach which has been employed in the program documented herein (Cooper et al., 1979; Kowalczyk et al., 1978). Regression analysis is very versatile in that it can be modified in various ways to handle the different conditions which can arise. Several such properties of the CMB problem, which require special features not provided by ordinary multiple regression analysis, are discussed below.

First, in the regression analysis, the C_i and C_T are the values of the dependent variable, and it is known that these values have different error variances. To account for this fact, weighted least squares should be used.

This approach differs from ordinary multiple regression in that the most accurate data are weighted most heavily in developing the regression equation. In ordinary multiple regression, all data are weighted equally. In weighted regression, the values of S_o and S_j, j=1 to m, are chosen so as to minimize the sum of squares SS:

$$SS = \sum_{i=1}^{n} \frac{(\hat{C}_i - C_i)^2}{s^2_{C_i}} + \frac{(\hat{C}_T - C_T)^2}{s^2_{C_T}} \qquad (4)$$

where

$\hat{C}_i$ and $\hat{C}_T$ are concentrations predicted by equations (2) and (3), respectively,

C_i and C_T are the corresponding measured concentrations,

$s^2_{C_i}$ and $s^2_{C_T}$ are the error variances of C_i and C_T, respectively, and

n is the number of chemical species being considered.

Second, in ordinary multiple regression analysis, it is assumed that the predictor variables have no error. In the CMB analysis, however, the values of the predictor variables (F_{ij}) have random errors. Approaches to account for these errors in the CMB analysis have been described by Watson (1979). In one approach, the C_i and F_{ij} values are all weighted according to their uncertainties in achieving a maximum-likelihood solution of the mass balance equations (Eq. 1). The approach requires an iterative solution, however, which sometimes fails to achieve convergence. A simpler method uses "effective variances" to account for the errors in the F_{ij}. In this approach, the variance of the total error in each mass balance equation, including the error of C_i and the errors in the terms involving the F_{ij}, is taken into account. The resulting effective variance for the i^{th} equation is

$$s^2_{EV_i} = s^2_{C_i} + \sum_{j=1}^{m} S_j^2 \, s^2_{F_{ij}} \qquad (5)$$

A weighted least squares analysis is performed, and effective variances are used in place of error variances of ambient concentration measurement error variances.

In the mass balance equation involving aerosol mass concentration (Eq. 3), the coefficients of the S_j are all unity and have zero error variances. Thus, the effective variance of this equation is simply the error variance of C_T. Using effective variances, then, increases the error variances associated with all other equations (Eq. 2) relative to the error variance for the equation involving aerosol mass concentration (Eq. 3). Thus, the use of effective variances increases the relative weight given to the aerosol mass equation (Eq. 3). Use of effective variances will not always improve the agreement between the measured and predicted aerosol mass concentrations, however. This is because of the complex shifting of the relative weights given to all the equations.

Since the effective-variance calculation involves the unknown S_j values, an initial solution estimate is required. Thus, an iterative approach can be used; the initial estimate at each stage is the solution from the preceding iteration.

Another important aspect of the CMB approach involves the difficulty in estimating the separate particulate contributions of sources whose aerosols have similar chemical compositions. If the compositions were identical, it would be impossible to differentiate between the aerosols from the two sources. If the compositions were very similar, differentiation would be possible but difficult to accomplish accurately. The problem is referred to in statistical terms as "multicollinearity." Stated more generally, multicollinearity exists when any source signature is very nearly a linear combination of any subset of the other signatures. In this case, it is difficult to distinguish among the aerosols emanating from the sources with nearly linearly dependent signatures. Multicollinearity can cause large random errors if conventional weighted least squares with or without effective variances is used. Negative values with large magnitudes can result from these errors.

Ridge regression is an approach for handling problems with multicollinearity. A brief summary of the properties of ridge regression which are essential to the discussion here is presented below. Ridge regression is discussed further by Vinod (1978), Hoerl and Kennard (1970a, b), Marquardt (1970), Swindel (1974), Marquart and Snee (1975), and Obenchain (1977). The use of ridge regression in source apportionment is discussed by Williamson, Balfour, and Schmidt (1982).

In ordinary regression analysis,

$$B = (x'x)^{-1}x'y \tag{6}$$

where

B is the vector of regression coefficients - in CMB analysis, the intercept S_o and the S_j,
x is the design matrix, here the source signature matrix,
y is the vector of values of the dependent variable, here the species and total particulate concentrations,
the prime indicates matrix transposition,
and the superscript $^{-1}$ indicates matrix inversion.

In ridge regression, a parameter k is introduced:

$$B(k) = (x'x + kI)^{-1}x'y \tag{7}$$

where

B(k) is the ridge solution corresponding to the parameter k, and
I is the identity matrix.

Notice that if k = 0, the ridge solution becomes the ordinary regression solution.

The usual practice is to standardize x'x and x'y to contain correlation coefficients. The B values obtained from Eq. 6 are then called standardized coefficients. The solution in terms of the original data units is obtained by an inverse transformation. The diagonal elements of x'x, then, are all one. A k value of, for example, 0.1 represents a 10 percent perturbation of the diagonal elements. If k is positive, a bias is introduced into the regression coefficients; the conventional regression solution is unbiased. However, the error variances of the coefficients, if inflated due to multicollinearities, often decrease rapidly as k increases. Thus, a much improved solution can be achieved when, by introducing a small bias, a large reduction of the random errors is accomplished.

Variance-inflation factors (Belsley et al., 1980) are convenient measures of the effect of multicollinearity in a given problem. The variance-inflation factor of a given regression coefficient (S_j) can be interpreted as the ratio of its error variance to the error variance it would have had if the predictor variables had been uncorrelated.

The covariance matrix C of the standardized regression coefficients is

$$C = (x'x)^{-1} \sigma^2 \qquad (8)$$

where σ^2 is the error variance of the dependent variable. The error variances of the regression coefficients are the diagonal elements of C. The error variances which would have been obtained if the predictor variables were uncorrelated are obtained by setting the off-diagonal elements of x'x equal to zero and employing Eq. 8. The variance inflation factors, then, are the ratios of the actual error variances to those obtained assuming uncorrelated predictor variables. The variance inflation factors apply either to the standardized or unstandardized regression coefficients, since the scale factors cancel in taking the ratio.

If multicollinearities are present, the regression coefficients are usually extremely sensitive to k for small values of k. However, as k increases, the coefficients stabilize. Hoerl and Kennard (1970a, b) recommend selecting a value of k in the stable region within which moderate changes in k do not affect the coefficients significantly.

A diversity of automatic statistical approaches for selecting k have been discussed in the literature, e.g., by Dempster et al. (1977), and Wichern and Churchill (1978). In the program documented herein, the user has the option of displaying the solutions for a set of values of k or letting the program select k. The automatic method is based on both statistical and physical criteria. The motivation for choosing the particular criteria used is as follows. Typically, when serious multicollinearities are present, in the weighted least squares solution, one S_j value in a collinear set will be excessively large and another will be negative with large magnitude. That is, one S_j value will blow up on the positive side and another will blow up on the negative side. Simply setting the negative values equal to zero, therefore, would solve only half of the problem.

As k increases, the negative values usually approach zero, and some or all of them may become positive. Thus, one criterion is to select k so as to minimize the magnitudes of the negative S_j values.

Another criterion is to optimize the agreement between the observed and calculated aerosol concentration for the size fraction being considered. This criterion involves the complete set of S_j values and has a reasonable physical basis. To address both criteria k is selected so as to minimize the following:

$$(\hat{C}_T - C_T)^2 + W\sum_{S_j<0} S_j^{\,2} \qquad (9)$$

where W is a user-specified weighting factor. Increasing W increases the relative importance of avoiding negative values with significant magnitudes. Decreasing W increases the relative importance of achieving agreement between the measured and calculated aerosol mass concentrations. The sum of squares of the negative S_j values is zero if there are no negatives.

While this is obviously only one of many possible schemes for selecting k, it is based on reasonable physical and statistical criteria. Nevertheless, neither this nor any automatic scheme can guarantee selection of the optimal value of k. However, the suggested scheme tends to select values of k in the stable region. Thus, slight deviation from the optimal k should not introduce significant errors in the solution.

Weighted regression, effective-variance calculations, and ridge regression all offer enhancements to the ordinary multiple regression approach to the CMB problem. Fortunately, these three features can be used simultaneously or in various combinations. In weighted regression, a transformation is first made to stabilize the error variance of the dependent variable (Draper and Smith, 1966). This transformation can be made using the original error variances of the dependent variable or the effective variances. Subsequently, the regression analysis is performed using the transformed variables; this can be accomplished using either ordinary regression or ridge regression. Finally, the necessary inverse transformation is performed to obtain the solution in the original data units.

The simultaneous use of the three features mentioned above requires certain minor changes to the procedures. For example, weighted ridge regression with an intercept is most easily carried out if x'x and x'y are normalized but not centered. Thus, x'x and x'y do not contain correlation coefficients, as in conventional ridge regression practices discussed above. However, the diagonal elements of x'x are unity, as in the conventional case. Thus, as before, a k value of 0.1 represents a 10 percent perturbation of the diagonal elements. This and other minor procedural changes do not impact the interpretability of the results.

In the discussion above, the expression for the covariance matrix of the standardized regression coefficients is given in Eq. 8. The quantity σ^2 is the error variance of the dependent variable; a common error variance applies after the transformation to stabilize the variance has been performed.

The quantity σ^2 is estimated by s, the conventional standard error:

$$s^2 = \frac{\sum_{i=1}^{n+1} (Y_i - \hat{Y}_i)^2}{n+1 - L} \qquad (10)$$

where

Y_i is the i^{th} value of the dependent variable, i.e., Y_i is the measured concentration of the i^{th} species, $1 \leq i \leq n$, and Y_{n+1} is the measured aerosol mass concentration after the transformation to standardize the variance,

$\hat{Y}_i$ is the i^{th} predicted value,

n is the number of species as before, and

L is the number of regression coefficients estimated - m+1 if the intercept is included and m if not.

The standard errors of the S_j values, then, are rescaled to the original data units in exactly the same manner as are the S_j values.

Thus, the input standard errors of the concentration and source signature data are used only for weighting purposes. Neither the S_j values nor their standard errors are directly proportional to the input standard errors. This is advantageous, since accurate estimates of the standard errors of the source signatures are not now available. The basic error measure s^2 is derived directly from the differences between observed and predicted concentrations.